BASIN-WIDE EVALUATION OF THE UPPERMOST GREEN RIVER FORMATION'S OIL-SHALE RESOURCE, UINTA BASIN, UTAH AND COLORADO

by
Michael D. Vanden Berg

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Cover photo: A sample of Utah oil shale collected from the White River Mine.

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BASIN-WIDE EVALUATION OF THE UPPERMOST GREEN RIVER FORMATION'S OIL-SHALE RESOURCE, UINTA BASIN, UTAH AND COLORADO

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ABSTRACT

Due to the recent increase in crude oil prices and concerns over diminishing conventional reserves, the Utah Geological Survey has reexamined the Uinta Basin's oil-shale resource, primarily in the Mahogany zone of the Green River Formation. Past assessments, the first conducted in 1964 and subsequent studies continuing through the early 1980s, concentrated on the Eocene Green River Formation's Mahogany zone in the southeastern part of the Uinta Basin, and were limited in the amount of drill hole data available at the time. We have broadened the investigation to include the entire Uinta Basin, taking advantage of the hundreds of geophysical logs from oil and gas wells drilled over the last two decades. We created conversion equations by correlating available Fischer assays with corresponding density and sonic measurements as a way to predict oil yield from geophysical logs. In addition to the core-based Fischer assays obtained from 107 wells drilled specifically for oil shale, 186 oil and gas wells with oil yields calculated from digitized bulk density or sonic logs were used to create a basin-wide picture of the oil-shale resource in the Uinta Basin. These widespread data were used to map oil-shale thickness and richness and create isopach maps delineating oil yields of 15, 25, 35, and 50 gallons of shale oil per ton (GPT) of rock. Thicknesses were centered around the extremely rich Mahogany bed of the Mahogany zone (R-7) within the Parachute Creek Member of the Green River Formation. From these isopach maps, new basin-wide resource numbers were calculated for each richness grade. In addition, oil-shale resource numbers were adjusted according to different sets of constraints, including resources less than 3000 feet deep, resources located on specific landownership categories, and resources associated with conventional oil and gas fields.

The thickest and richest oil-shale zones are located in central Uintah County in T. 8 S. to T. 12 S. and R. 20 E. to R. 25 E., Salt Lake Base Line and Meridian. Overburden in these areas ranges from zero at the outcrop in the east, to almost 4000 feet farther to the northwest. A continuous interval of oil shale averaging 50 GPT contains an in-place oil resource of 31 billion barrels in a zone ranging up to 20 feet thick. Where the 50 GPT interval is at least 5 feet thick and less than 3000 feet deep, the in-place resource drops to 26 billion barrels. An interval averaging 35 GPT, with a maximum thickness of 55 feet, contains an in-place oil resource of 76 billion barrels. Where this interval is at least 5 feet thick and less than 3000 feet deep, the total in-place resource drops to 61 billion barrels. The 25 GPT zone and the 15 GPT zone contain unconstrained resources of 147 billion barrels and 292 billion barrels, respectively. The maximum thickness of 25 GPT rock is about 130 feet, whereas the maximum thickness of 15 GPT rock is about 500 feet. Where these two intervals are at least 5 feet thick and less than 3000 feet deep, the 25 GPT resource drops to 111 billion barrels and the 15 GPT resource drops to 228 billion barrels.

The 25 GPT resource calculated for U.S. Bureau of Land Management (BLM) lands that could be considered for commercial oil-shale leasing is approximately 69 billion barrels, roughly 50% of Utah's total oil-shale resource. The remaining resource is located on tribal (20%), private (16%), state trust (9%), U.S. Forest Service (3%), and protected land (2%) such as state wildlife reserves, national wildlife refuges, state sovereign lands, and state parks. Furthermore, approximately 25% of Utah's oil-shale resource lies within existing oil or gas fields, creating resource conflict issues that will need to be addressed as conventional and unconventional resources are developed.

After placing several constraints on Utah's total in-place oil-shale resource, we determined that approximately 77 billion barrels of oil could be considered as a potential economic resource. This estimate is for deposits that are at least 25 GPT; at least 5 feet thick; under less than 3000 feet of cover; not in conflict with current conventional oil and gas resources; and located only on BLM, state, private, and tribal lands.

INTRODUCTION AND BACKGROUND

In the 1960s, the U.S. Department of Interior started an aggressive program to describe and estimate the Green River Formation oil-shale resource. The dramatic increase in petroleum prices resulting from the Organization of the Petroleum Exporting Countries (OPEC) oil embargo of 1973 triggered a second resurgence of oil-shale research during the 1970s and early 1980s. When oil prices plummeted in the mid-1980s, so did research associated with oil shale. With recent crude oil prices again rising to new heights, and as conventional crude oil supplies continue to diminish, interest in unconventional fuel sources such as oil shale has been renewed.

The largest known oil-shale deposits in the world are in the Eocene Green River Formation, which covers portions of Utah, Colorado, and Wyoming (figure 1). Lacustrine sediments of the Green River Formation were deposited in two large lakes that occupied a 25,000-square-mile area in the Piceance, Uinta, Green River, and Washakie sedimentary basins. Fluctuations in stream inflow caused large expan-

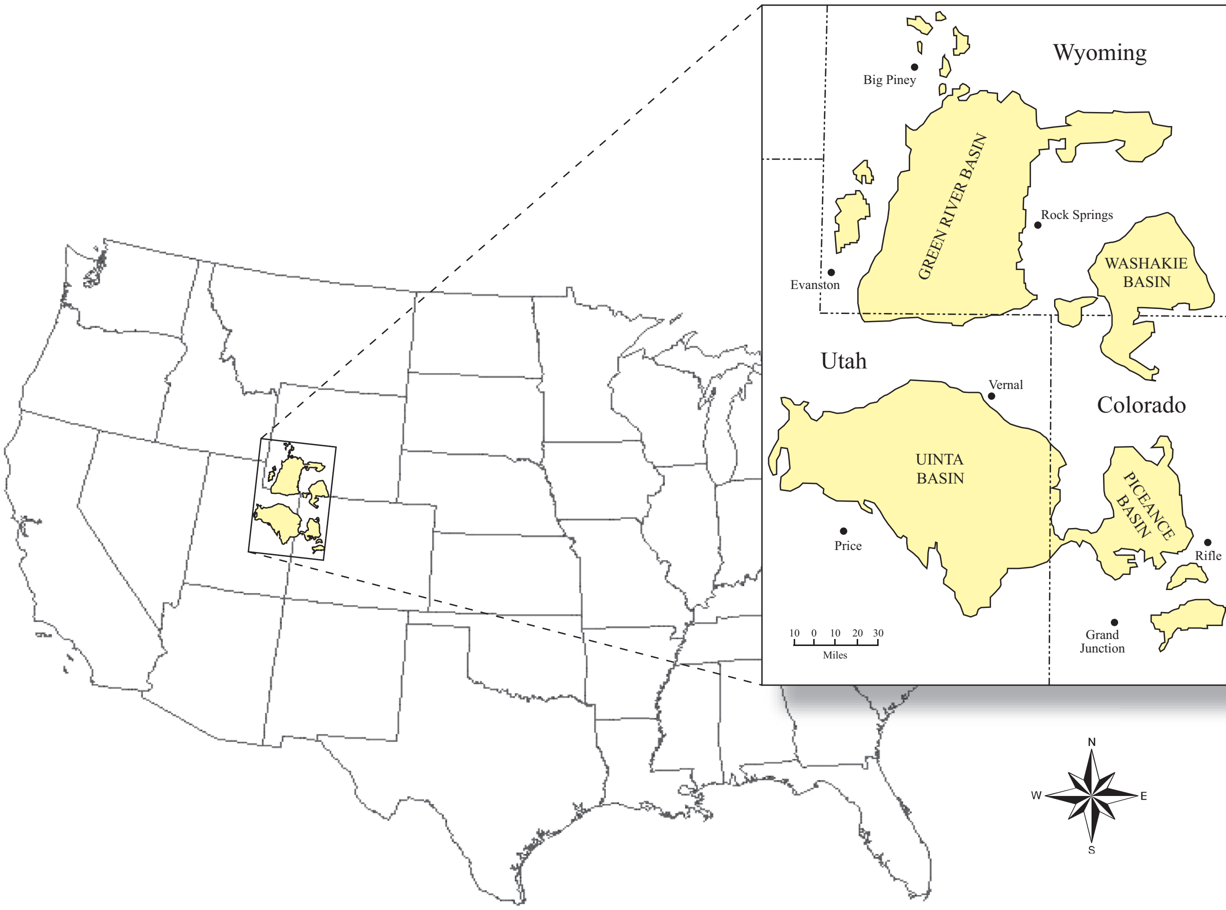

Figure 1. *Oil-shale resource areas of Utah, Colorado, and Wyoming (adapted from Bartis and others, 2005, and Bunger and others, 2004).*

sions and contractions of the lakes, as evidenced by widespread intertonguing of marly lacustrine strata with beds of land-derived sandstone and siltstone. During arid times, the lakes contracted in size and the lake waters became increasingly saline and alkaline (Dyni, 2003). The warm alkaline waters provided excellent conditions for the abundant growth of cyanobacteria (blue-green algae), which is thought to be the major precursor of the organic matter in the oil shale (Dyni, 2003). The organic matter preserved in the shale is called kerogen, which when heated can produce crude oil and natural gas. Figure 2 shows a stratigraphic section of the Parachute Creek Member of the upper Green River Formation in the Uinta Basin, Utah as it appears in corehole U044 (section 22, T. 9 S., R. 23 E., Salt Lake Base Line and Meridian [SLBLM]). The section with the richest oil shale is named the Mahogany zone (R-7), where individual beds, such as the Mahogany bed, can exceed 70 gallons of oil per ton of rock and the entire zone is commonly over 100 feet thick.

The entire length of the Mahogany zone outcrop has been mapped at the 1:100,000 and/or 1:24,000 scale and defines the southern boundary of the study area. The southeastern extent of the outcrop was digitized from 14 7.5-minute quadrangles, and the remaining sections of outcrop were digitized from three 30' x 60' geologic maps. The 14 7.5-minute quadrangles are Agency Draw NE (Pipiringos, 1979), Agency Draw NW (Cashion, 1984), Bates Knolls (Pipiringos, 1978), Burnt Timber Canyon (Keighin, 1977a), Cooper Canyon (Keighin, 1977b), Davis Canyon (Pantea, 1987), Dragon (Scott and Pantea, 1985), Flat Rock Mesa (Pantea and Scott, 1986), Nutters Hole (Cashion, 1994), Rainbow (Keighin, 1977c), Southam Canyon (Cashion, 1974), Walsh Knolls (Cashion, 1978), Weaver Ridge (Cashion, 1977), and Wolf Point (Scott and Pantea, 1986). The 30' x 60' maps are the Huntington (Witkind, 1988), Price (Weiss and others, 1990), and Westwater (Gualtieri, 1988).

Estimates of the in-place oil-shale resource within the entire Green River Formation range from 1.5 trillion (Smith, 1980; Dyni, 2003) to 1.8 trillion barrels (Culbertson and Pitman, 1973; U.S. Federal Energy Administration, 1974). Historical estimates of the Utah portion of this resource vary from 165 billion barrels (Smith, 1980) to 214 billion barrels (Trudell and others, 1983) to 321 billion barrels (Cashion, 1964). Colorado and Wyoming are thought to contain 1.0 trillion and 300 billion barrels, respectively (Smith, 1980; Pitman and others, 1989; Culbertson and others, 1980; Trudell and others, 1973). These in-place resource estimates are based on oil shale with a minimum grade of 15 gallons per ton with no constraints on overburden thickness, which in Utah can reach over 9000 feet. In addition, these in-place resource numbers should not be compared to conventional oil reserves, as is often the case (a resource is the total amount of a particular commodity available in the ground, a reserve is the amount of that commodity that can be economically recovered). No commercial technology is currently available to extract oil from oil shale; therefore, accurate reserve numbers can not be calculated.

With previous Utah-based studies typically only utiliz-

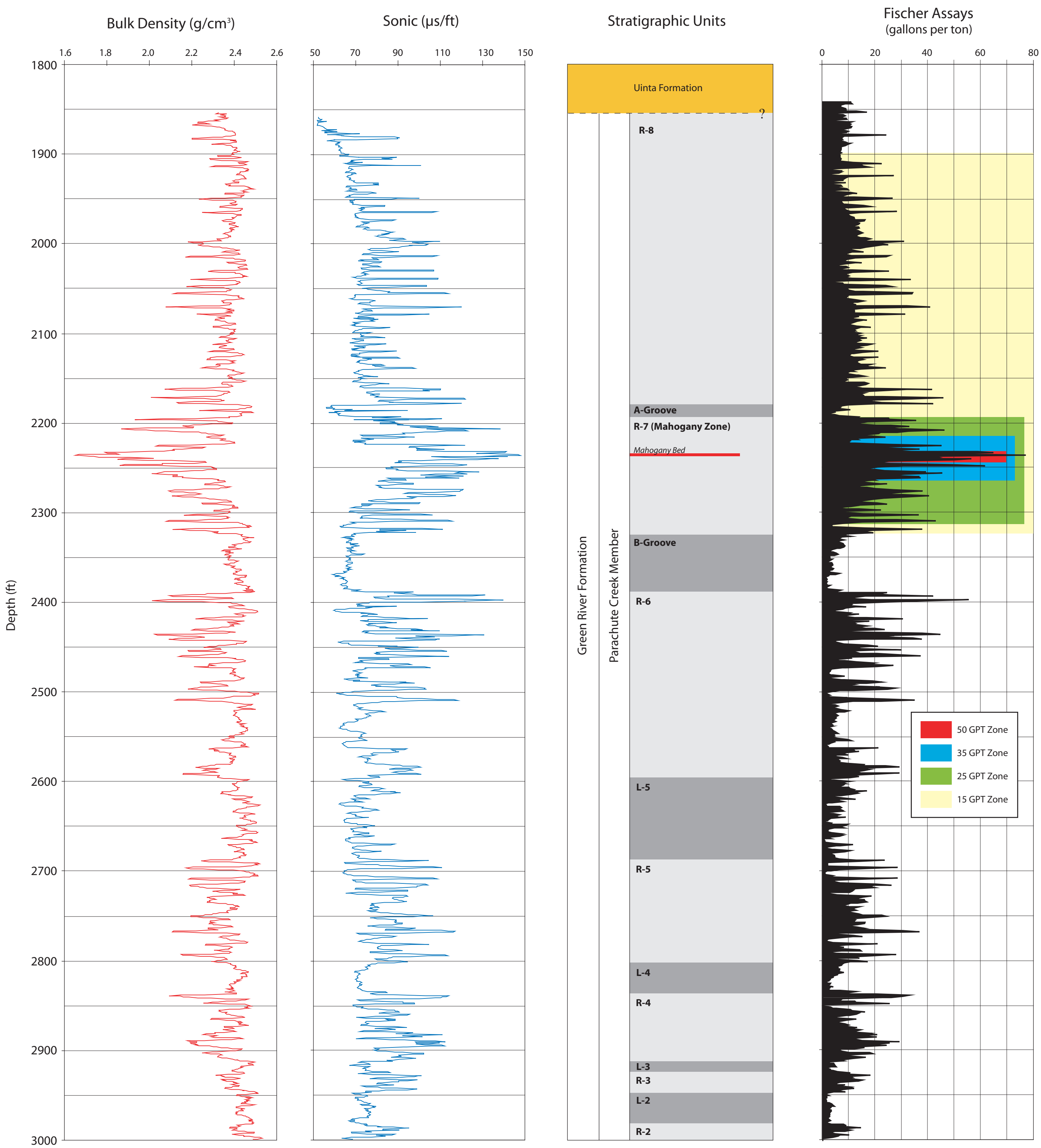

Figure 2. *Stratigraphy of the Parachute Creek Member of the upper Green River Formation illustrated by bulk density, sonic, and oil-yield plots from well U044 (section 22, T. 9 S., R. 23 E., SLBLM). "R" refers to a rich oil-shale zone and "L" refers to a lean oil shale zone (stratigraphic nomenclature for oil-shale zones derived from Donnell and Blair, 1970, and Cashion and Donnell, 1972).*

ing oil-shale-specific wells drilled in Uintah County, earlier resource estimates had to rely heavily on extensive extrapolation into areas having no drill holes or oil-yield analyses. In addition, each study looked at different oil-shale horizons. For example, Trudell and others (1983) looked at oil shale only within and above the Mahogany zone, while significant resources are also available in the shales below this horizon (figure 2).

Roughly 180 oil-shale-specific wells were drilled between 1954 and 1983 and their cores were analyzed for oil yield using the modified Fischer assay technique, as described by Stanfield and Frost (1949) and later adopted by the American Society for Testing and Materials (1980). This method was developed primarily for evaluating the Green River oil-shale resources. Generally, the assays of drill cores were made on crushed samples prepared from one- or two-foot lengths of quartered core. A complete database of Fischer assays for wells from the state of Utah can be found in Vanden Berg and others (2006). These wells were typically located in central to southern Uintah County, typically near the well-mapped outcrop of the Mahogany zone, the richest oil-shale horizon. A few wells, drilled farther west and north, reached the Mahogany zone at more than 2000 feet below the surface.

Fischer assays were also performed on rotary cuttings from oil and gas wells averaged over 10-foot intervals. However, these data are unreliable due to contamination by mixing of cuttings, contamination from borehole cave-ins, and depth errors resulting when the samples were inaccurately lagged for travel time up the borehole. Also, with averages over such a wide spacing, accurate zone thicknesses could not be calculated, especially for the 50 GPT zone. Because these data are generally unreliable and typically underestimate the resource, assays from rotary cuttings were not used in this study.

METHODS

Resource Calculations and Isopach Maps

The first step in creating a basin-wide oil-shale resource assessment was to determine how geophysical logs from hundreds of oil and gas wells in the region could be related to the oil yield of oil shale. Previous researchers determined that bulk density logs display an excellent inverse correlation to oil yield obtained using the modified Fischer assay technique; the more kerogen-rich the oil shale, the less dense the material (Bardsley and Algermissen, 1963; Tixier and Curtis, 1967; Smith and others, 1968; Dyni and others, 1991) (figures 2 and 3, table 1). A sonic log also shows a correlation with oil yield, albeit not as significant as bulk density, displaying higher travel times in the less dense, kerogen-rich intervals (figures 2 and 3, table 1). To characterize these correlations, UGS digitized old paper copies of bulk density and sonic logs from oil-shale wells that also had core-based oil yields determined by Fischer assay. The core-based Fischer assays were typically performed on a one-foot spacing, with half-foot spacing in the highest yielding zones and up to three-foot spacing in the leaner zones. Bulk density logs from 14 wells and sonic logs from nine wells were digitized using Neuralog software. Several other wells having both density or sonic logs and oil-yield data were available; however, many logs lacked identifiable scaling, while other wells contained large data gaps within the oil-yield analyses. After digitizing the logs at half-foot intervals, cross-plots were generated relating the bulk density or sonic measurements with oil yields after they were fitted to the same half-foot depth scale. Next, the cross-plots were analyzed using a simple linear regression model (table 1). In some cases, the log data needed to be manually shifted along the depth scale to match with the corresponding intervals measured for oil yield. This was done by visually comparing the two curves and matching various peaks and zones. In addition, spurious data spikes were eliminated from the Fischer assays and the digital logs.

After analyzing the individual regressions, we discarded wells having poor results, typically R^2 values less than 0.7 for density logs and less than 0.6 for sonic logs. This left a total of eight wells relating bulk density to oil yield, with Mahogany bed depths ranging from 100 to 2650 feet, and four wells relating sonic to oil yield, with Mahogany bed depths ranging from 660 to 2230 feet (table 1).

Since both variables, the geophysical and oil-yield logs, are subject to measurement errors, we decided to apply a reduced-major-axes fit to a combination of all the data. This was done separately for both the bulk density and sonic logs creating an equation for each (figure 3, table 1). This method provided two robust equations that could be applied to other wells with density or sonic logs located throughout the basin and at various depths. The equation for relating bulk density to oil yield in gallons per ton was determined to be:

$$\text{(1)} \qquad \text{oil yield} = -80.894\rho + 203.996$$

were ρ equals the bulk density value in grams per cubic centimeter (g/cm^3). The equation for relating sonic logs to oil yield in gallons per ton was determined to be:

$$\text{(2)} \qquad \text{oil yield} = 0.766\Delta\tau - 49.237$$

were $\Delta\tau$ equals travel time in microseconds per foot (µs/ft). Dyni and others (1991) argued that the regression was slightly improved for the sonic logs with a second-degree polynomial equation. However, this study found that a second-degree polynomial, even though the R^2 was slightly higher, calculated oil yields notably higher than nearby wells with Fischer assay analyses. The simpler linear equation shown above (2) was determined to be more robust.

After the equations relating oil yield to geophysical log were created, oil and gas wells with these particular logs had to be found throughout the Uinta Basin. The goal was to try to find at least one well per township, while adding additional wells in areas of particular interest. One difficulty was finding wells with log data for the oil-shale-bearing portion (i.e., Mahogany zone) of the Green River Formation. Since many oil and gas wells in the basin have targets far below this formation, several companies simply did not log the upper part of the borehole. After an extensive search, 186 wells, 167 with adequate bulk density logs and 19 with adequate sonic logs, were chosen (see appendix). Since density logs display a better correlation with oil yield, preference was given to those logs. Wells with sonic logs were used to fill in data gaps. Unfortunately, only image files of these logs exist, at least in the public domain, so all logs had to be manually digitized using NeuraLog software.

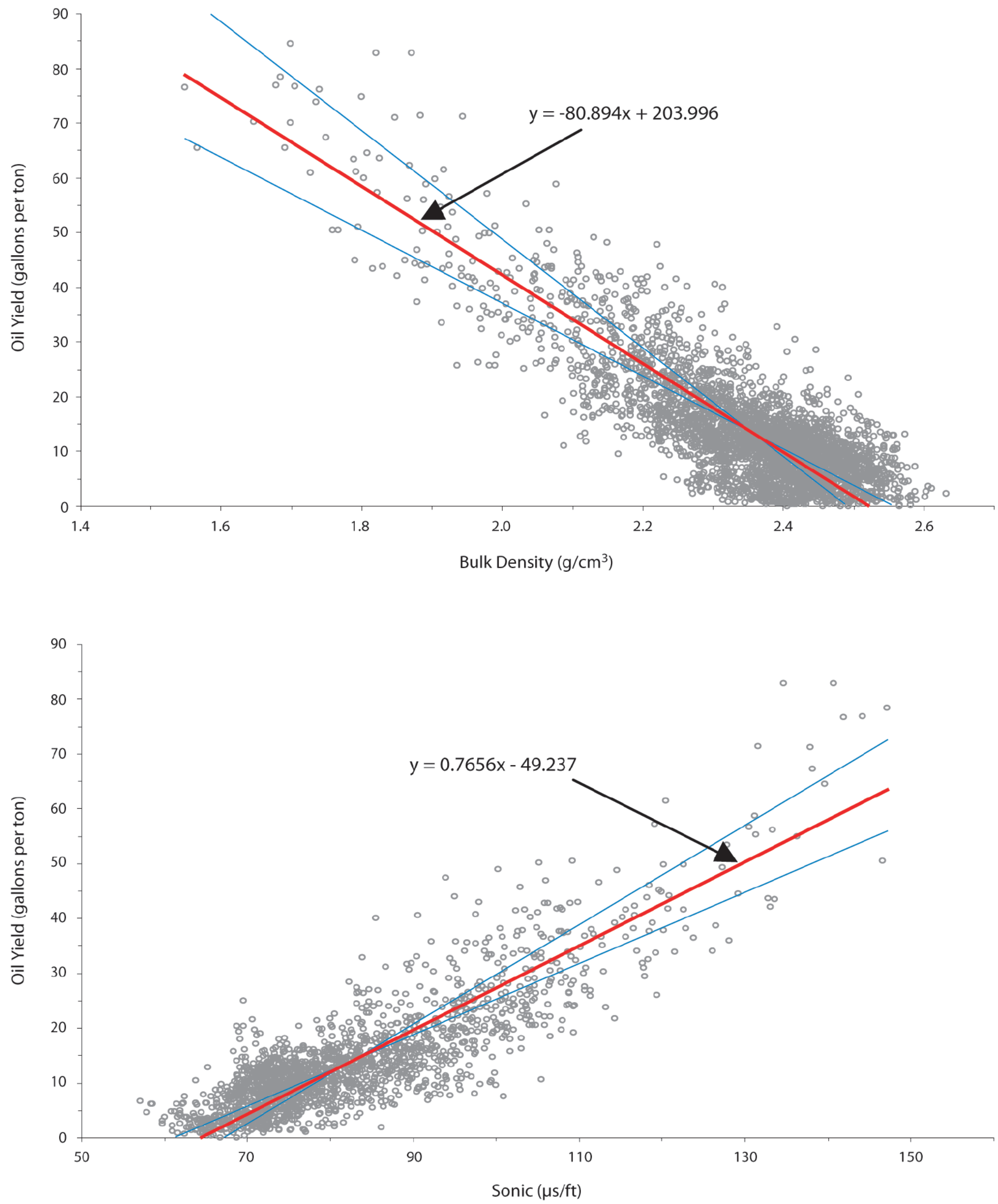

Figure 3. *Reduced-major-axes regression relating bulk density and sonic log readings to oil yield.*

With the creation of digitized geophysical logs in which data were recorded on a half-foot spacing, the above equations could be systematically applied to create calculated oil-yield logs for all 186 wells. In cases of particularly high density or particularly low sonic values, the equations predicted negative yield values. These negative intervals were adjusted to equal zero gallons per ton.

The next step was to calculate the thickness of continuous intervals of oil shale averaging 15, 25, 35, and 50 gallons per ton. These intervals were determined for all 186 oil and gas wells with calculated assay data, as well as 107 oil-shale-specific wells with assays derived from core, for a total of 293 wells. These continuous zones were calculated starting at the Mahogany bed, adding assay values above or below until the desired average oil yield was found (see appendix). In some cases, the depth interval measured by the log or Fischer assay was limited, and a total thickness for the 15 and/or 25 GPT zone could not be found. When this occurred, the thickness was estimated using a ratio of the thicknesses of the 25/15 GPT zones, or the 35/25 GPT zones, from a nearby well. These estimated values are indicated by italic font in the appendix.

Using ArcGIS software, isopachs for the thickness of each richness zone were plotted using a spline fit with tension. In some cases, individual thickness values were edited to remove spurious "bulls-eyes" from the isopachs; these edited values are indicated in italic font in the appendix. The northern boundary of the isopachs is simply the extent of the available data, whereas the southern boundary is delineated by the outcrop of the Mahogany zone. The area mapped was divided into the smallest thickness intervals possible—0.1 feet for the 50 GPT zone, 0.25 feet for the 35 GPT zone, 0.5 feet for the 25 GPT zone, and 2.5 feet for the 15 GPT zone—and the sub-areas underlain by each thickness interval were

Table 1. *Equations used to calculate oil shale richness from density and sonic logs.*

USGS #	Bulk Density Log			Sonic Log		
	Individual regression equation	R^2	RMA equation relating all data	Individual regression equation	R^2	RMA equation relating all data
U153	y=-90.69x + 223.95	0.76				
U061				y=0.76x - 48.33	0.69	
U065	y=-67.24x + 177.41	0.73		y=0.73x - 45.50	0.69	
U059	y=-66.83x + 173.24	0.71				
U092	y=-75.72x + 193.14	0.73	y=-80.894x + 203.996			y=0.766x - 49.237
U085	y=-70.72x + 183.35	0.74		y=0.61x - 34.97	0.64	
U044	y=-85.50x + 213.46	0.84		y=0.63x - 38.29	0.77	
U102	y=-68.92x + 178.22	0.73				
U045	y=-87.17x + 209.63	0.87				

USGS #	Mahogany Bed Depth to bed (ft)	Twn	Rng	Sec	Mrd	UTM E	UTM N
U153	100	12S	24E	25	SL	656186	4401431
U061	659	10S	24E	14	SL	655055	4424178
U065	696	10S	25E	19	SL	657974	4422591
U059	719	10S	25E	19	SL	659426	4421812
U092	1027	9S	25E	16	SL	661008	4432488
U085	1965	9S	24E	32	SL	649994	4427496
U044	2236	9S	23E	22	SL	644158	4431449
U102	2313	9S	21E	26	SL	627029	4429992
U045	2646	9S	22E	1	SL	637424	4436007

RMA = Reduced Major Axes, Twn = Township, Rng = Range,
Sec = Section, Mrd = Meridian, SL = Salt Lake Base Line and Meridian

calculated using the ArcGIS program. To estimate the oil-shale resource, rock volumes were calculated by multiplying the area of a given polygon by its average thickness. The thinner the thickness interval mapped, the more precise the estimated volume and the more precise the resource calculation because a more accurate thickness is applied to each area. Next, the average density (see figure 3) of the given richness was used to calculate the weight of oil shale in tons, which then could be converted to a resource estimate in barrels of in-place oil by multiplying the tons by the assayed or estimated oil yield (in GPT). All calculated resource numbers for each richness zone, separated into various thickness bins, can be found in table 2a. Maps displaying the isopach data, separated into corresponding thickness intervals, are displayed in plates 1, 2, 3, and 4.

Overburden Thickness

Plates 1, 2, 3, and 4 also display overburden contours indicating the depth to the top of the individual richness zones. These contours were created by subtracting the footage below the surface to the top of the richness interval from the surface elevation of the well to arrive at the elevation of the oil-shale horizon of interest. A structure contour map was generated in ArcGIS displaying the surface of each richness interval in feet above sea level. This structure contour map was then subtracted from a digital elevation model of the Uinta Basin providing accurate overburden thickness contours. A few estimated data points were added in areas having little or no oil-shale data as a means to provide more geologically accurate overburden contours, particularly near the outcrop. Overburden thickness equals zero at the outcrop in the southern and eastern portions of the basin and gradually increases in thickness, up to 9000 feet, to the north.

Economic Constraints

After total in-place resource estimates were calculated, several constraints were imposed on the total endowment to offer a more realistic impression of the potentially economic oil-shale resource. We assumed that mining, underground and/or surface mining, would generally not occur where the resource is less than 5 feet thick for 25, 35, and 50 GPT rock or less than 15 feet thick for 15 GPT rock. Also, we assumed that mining would not occur where overburden is more than 3000 feet. In addition, since all land will likely not be available for oil-shale extraction, resource numbers were calculated by landownership. Finally, we assumed that conventional oil and gas and oil-shale deposits will not be simultaneously produced, so oil-shale resources for lands outside and within current conventional oil and gas fields were also calculated. These constrained resource estimates are available in tables 2, 3, and 4 and are described in more detail below.

Constraints based on in-situ processing were not considered since a proven in-situ technique has not been developed. Shell's In-situ Conversion Process (ICP), currently being tested in western Colorado's Piceance Basin, is targeting oil shale from a zone between 1000 to 2000 feet thick that averages roughly 30 to 35 GPT (Shell Oil Company, 2008). Utah's 35 GPT zone reaches only 55 feet in thickness, dramatically thinner than oil-shale resources in Colorado. Other types of in-situ processes might be more adaptable to Utah's thinner deposits in the future, but currently, all in-situ demonstration projects are in the thick deposits of Colorado's Piceance Basin.

RESULTS

Total In-Place Resource

A continuous section of oil shale averaging 50 GPT in the Uinta Basin of Utah contains approximately 31 billion barrels of in-place oil, including approximately 23 billion barrels in deposits between 5 and 20 feet thick (table 2a).

The 50 GPT interval is contained entirely within the Mahogany zone and is centered on the Mahogany bed (R-7, see figure 2). The thickest deposits, 15 to 20 feet, of 50 GPT rock are located in T. 10 S., R. 22-24 E., SLBLM, as well as the northern sections of T. 11 S., R. 24-25 E. and the eastern sections of T. 9 S., R. 21 E. (plate 1). The top of the 50 GPT zone in these areas ranges in depth from 450 to 2500 feet. Potentially economic thicknesses, at least 5 to 10 feet, of 50 GPT rock are near the outcrop on the eastern side of the study area. In addition to the large resource in the eastern part of the basin, a long finger of rich oil shale ranging in thickness from 5 to 10 feet extends westward through the southern portion of Duchesne County. These deposits range from 2000 to 3000 feet below the surface. Oil-shale deposits averaging 50 GPT and located less than 3000 feet below the surface contain approximately 26 billion barrels of oil, including 20 billion barrels found in deposits between 5 and 20 feet thick (table 2b).

A continuous section of oil shale averaging 35 GPT contains approximately 76 billion barrels of in-place oil, including 73 billion barrels in deposits ranging between 5 and 55 feet thick (table 2a). The 35 GPT interval is also contained entirely within the Mahogany zone, centered on the Mahogany bed. The thickest interval, 40 to 55 feet, is located in T. 9 S., R. 21-23 E., SLBLM, and T. 10 S., R. 21-24 E. (plate 2). The top of the 35 GPT zone in this area ranges in depth from 800 to 2500 feet. Again, reasonably thick deposits, 10 to 40 feet, are located near outcrop along the eastern extent of the study area. Similar to the 50 GPT zone, the 35 GPT zone exhibits a long finger extending westward through the southern part of Duchesne County. This zone reaches 38 feet thick and is located under depths ranging from outcrop to 2500 feet. Oil-shale deposits averaging 35 GPT and located less than 3000 feet below the surface contain approximately 61 billion barrels of oil, including 59 billion barrels found in deposits between 5 and 55 feet thick (table 2b).

A continuous section of oil shale averaging 25 GPT contains approximately 147 billion barrels of in-place oil, including 146 billion barrels in deposits 5 to 130 feet thick (table 2a). The 25 GPT interval is typically within the Mahogany zone; however, in some cases the 25 GPT zone includes part of the A- or B-grooves (figure 2). The thickest interval, 100 to 130 feet, of 25 GPT rock is located in T. 9 S., R. 21-24 E., SLBLM, T. 10 S., R. 22-24 E., and other small areas within T. 8 S., R. 20-23 E. (plate 3). The top of these deposits ranges in depth from 750 to roughly 3500 feet. Near the outcrop, on the eastern side of the basin, deposits averaging 25 GPT are 40 to 100 feet thick. In southern Duchesne County, the 25 GPT zone ranges up to 60 feet thick with

Table 2a. *The Uinta Basin's total Green River Formation oil-shale resource, grouped by grade and thickness.*

50 GPT

Thickness (ft)	0-5	5-10	10-15	15-20
Total volume (billion ft^3)	112.8	198.6	90.8	29.1
Average density		1.90 g/cm^3	(0.0593 tons/ft^3)	
Billion tons	6.7	11.8	5.4	1.7
Billion barrels	8.0	14.1	6.4	2.1
Total resource (billion barrels)			**30.5**	

35 GPT

Thickness (ft)	0-5	5-10	10-20	20-30	30-40	40-55
Total volume (billion ft^3)	58.6	155.9	447.8	326.4	269.7	142.6
Average density			2.09 g/cm^3	(0.0652 tons/ft^3)		
Billion tons	3.8	10.2	29.2	21.3	17.6	9.3
Billion barrels	3.2	8.5	24.3	17.7	14.7	7.7
Total resource (billion barrels)				**76.1**		

25 GPT

Thickness (ft)	0-5	5-20	20-40	40-60	60-80	80-100	100-130
Total volume (billion ft^3)	37.6	366.6	944.1	765.0	454.6	569.7	448.0
Average density			2.21 g/cm^3	(0.0690 tons/ft^3)			
Billion tons	2.6	25.3	65.2	52.8	31.4	39.3	30.9
Billion barrels	1.5	15.1	38.8	31.5	18.7	23.4	18.4
Total resource (billion barrels)				**147.4**			

15 GPT

Thickness (ft)	0-15	15-100	100-200	200-300	300-400	400-500
Total volume (billion ft^3)	130.7	3178.8	2776.4	1568.2	2650.3	916.7
Average density			2.34 g/cm^3	(0.0730 tons/ft^3)		
Billion tons	9.5	231.8	202.5	114.4	193.3	66.9
Billion barrels	3.4	82.8	72.3	40.8	69.0	23.9
Total resource (billion barrels)				**292.3**		

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

Table 2b. *The Uinta Basin's total Green River Formation oil-shale resource with less than 3000 feet of overburden, grouped by grade and thickness.*

50 GPT

Thickness (ft)	0-5	5-10	10-15	15-20
Total volume (billion ft^3)	82.1	172.1	80.1	29.1
Average density		1.90 g/cm^3	(0.0593 tons/ft^3)	
Billion tons	4.9	10.2	4.8	1.7
Billion barrels	5.8	12.2	5.7	2.1
Total resource (billion barrels)			**25.7**	

35 GPT

Thickness (ft)	0-5	5-10	10-20	20-30	30-40	40-55
Total volume (billion ft^3)	32.1	75.0	366.4	280.9	228.4	141.5
Average density			2.09 g/cm^3	(0.0652 tons/ft^3)		
Billion tons	2.1	4.9	23.9	18.3	14.9	9.2
Billion barrels	1.7	4.1	19.9	15.3	12.4	7.7
Total resource (billion barrels)				**61.1**		

25 GPT

Thickness (ft)	0-5	5-20	20-40	40-60	60-80	80-100	100-130
Total volume (billion ft^3)	28.7	192.0	659.5	601.4	363.0	480.5	414.0
Average density			2.21 g/cm^3	(0.0690 tons/ft^3)			
Billion tons	2.0	13.3	45.6	41.5	25.1	33.2	28.6
Billion barrels	1.2	7.9	27.1	24.7	14.9	19.8	17.0
Total resource (billion barrels)				**112.6**			

15 GPT

Thickness (ft)	0-15	15-100	100-200	200-300	300-400	400-500
Total volume (billion ft^3)	105.0	1890.7	1986.1	1227.1	2640.0	916.7
Average density			2.34 g/cm^3	(0.0730 tons/ft^3)		
Billion tons	7.7	137.9	144.8	89.5	192.5	66.9
Billion barrels	2.7	49.2	51.7	32.0	68.8	23.9
Total resource (billion barrels)				**228.3**		

Note: Totals may not equal sum of components because of independent rounding
GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

deposits roughly 500 to 3000 feet deep. Deposits averaging 25 GPT that are located less than 3000 feet below the surface contain approximately 113 billion barrels of oil, including 111 billion barrels found in deposits between 5 and 130 feet thick (table 2b).

Finally, a continuous section of oil shale averaging 15 GPT contains approximately 292 billion barrels of in-place oil, including 289 billion barrels available in deposits greater than 15 feet thick (table 2a). This resource estimate is 10% lower than Cashion's 1964 in-place oil-shale resource estimate of 321 billion barrels for deposits containing at least 15 GPT at a minimum thickness of 15 feet. The availability of more drill hole data allows the new estimate to be more reliable than Cashion's (1964) estimate by identifying the areas of thick, rich oil shale more precisely. The 15 GPT interval includes all or parts of the R-6, B-Groove, R-7 (Mahogany Zone), A-Groove, and R-8 oil-shale zones (see figure 2). The thickest intervals, 400 to 500 feet, are primarily located in T. 9 S., R. 21-25 E., SLBLM, and T. 10 S., R. 23-24 E. where depths to the top of the zone range between 600 and 2300 feet (plate 4). Deposits near the eastern outcrop range from 100 to 400 feet thick. Deposits averaging 15 GPT that are less than 3000 feet below the surface contain approximately 228 billion barrels of oil, including 226 billion barrels in deposits between 15 and 500 feet thick (table 2b).

Resource by Landownership

Table 3 shows a breakdown of the Uinta Basin's oil-shale resource by landownership. Roughly 50% of oil shale is located on lands administered by the BLM. Tribal, private, state trust, and U.S. Forest Service lands hold the next-largest resource with about 20%, 16%, 9%, and 3% of total, respectively (average for all grades). The remaining 2% is locked up in protected lands such as state wildlife reserves, national wildlife refuges, state sovereign lands (mostly land under the Green River), and state parks. In addition, less than 1% of the Uinta Basin's oil-shale resource lies over the border in Colorado.

Plate 5 shows 25 GPT isopach contours displayed over top of landownership. The thickest interval of 25 GPT rock, between 100 and 130 feet thick, is located primarily on BLM land and contains 13.5 billion barrels or 73% of the resource at this thickness and richness. Several state blocks and large areas of private land are located near the eastern outcrop of

Table 3. *The Uinta Basin's total Green River Formation oil-shale resource grouped by grade, thickness, and landownership.*

50 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-15	15-20	Total	% of Total
U.S. Bureau of Land Management	2.7	7.1	4.1	1.6	15.4	50.5%
Indian Reservation	1.8	3.1	0.9	0.2	6.0	19.7%
Private	1.8	1.7	0.6	0.1	4.2	13.8%
State Trust Lands	0.5	1.2	0.8	0.2	2.7	8.9%
U.S. Forest Service	0.9	0.5	0.0	0.0	1.4	4.6%
State Wildlife Reserve - Management area	0.2	0.3	0.0	0.0	0.5	1.6%
U.S. Fish & Wildlife - National Wildlife Refuge	*	*	*	0.0	0.1	0.3%
State Soveriegn Lands	*	*	*	0.0	0.1	0.3%
State Parks and Recreation	*	0.0	0.0	0.0	*	--
Colorado Portion	0.1	*	0.0	0.0	0.1	0.3%
Total resource	**8.0**	**14.0**	**6.4**	**2.1**	**30.5**	

35 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-20	20-30	30-40	40-55	Total	% of Total
U.S. Bureau of Land Management	0.9	1.8	9.9	11.4	8.5	5.3	37.7	49.5%
Indian Reservation	0.7	2.0	5.7	2.3	3.0	0.9	14.7	19.3%
Private	1.1	3.4	3.5	1.7	1.8	0.1	11.6	15.2%
State Trust Lands	0.2	0.2	1.7	1.7	1.3	1.4	6.6	8.7%
U.S. Forest Service	0.2	0.7	2.4	0.0	0.0	0.0	3.3	4.3%
State Wildlife Reserve - Management area	0.1	0.2	0.8	0.2	0.0	0.0	1.3	1.7%
U.S. Fish & Wildlife - National Wildlife Refuge	*	*	*	*	0.1	0.0	0.2	0.3%
State Soveriegn Lands	*	*	*	0.1	0.1	0.0	0.2	0.3%
State Parks and Recreation	*	*	0.0	0.0	0.0	0.0	0.1	0.1%
Colorado Portion	0.0	*	0.2	0.3	0.0	0.0	0.5	0.7%
Total resource	**3.2**	**8.5**	**24.3**	**17.7**	**14.7**	**7.7**	**76.1**	

25 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-20	20-40	40-60	60-80	80-100	100-130	Total	% of Total
U.S. Bureau of Land Management	0.5	3.8	13.5	19.0	10.6	10.6	13.5	71.6	48.6%
Indian Reservation	0.4	3.2	8.8	4.4	2.8	6.6	2.1	28.3	19.2%
Private	0.4	5.4	9.7	4.0	2.3	2.9	0.6	25.3	17.2%
State Trust Lands	0.2	0.5	2.0	3.0	1.9	3.1	2.0	12.6	8.5%
U.S. Forest Service	0.1	1.5	3.5	0.0	0.0	0.0	0.0	5.0	3.4%
State Wildlife Reserve - Management area	*	0.5	1.1	0.7	0.0	0.0	0.0	2.3	1.6%
U.S. Fish & Wildlife - National Wildlife Refuge	*	*	0.1	0.1	*	0.1	0.2	0.5	0.3%
State Soveriegn Lands	*	*	*	0.1	0.1	0.1	*	0.3	0.2%
State Parks and Recreation	*	0.2	0.1	0.0	0.0	0.0	0.0	0.3	0.2%
Colorado Portion	0.0	0.0	*	0.2	1.0	0.0	0.0	1.3	0.9%
Total resource	**1.5**	**15.1**	**38.8**	**31.5**	**18.7**	**23.4**	**18.4**	**147.4**	

15 GPT (resource numbers in billion barrels)

Thickness (feet)	0-15	15-100	100-200	200-300	300-400	400-500	Total	% of Total
U.S. Bureau of Land Management	1.0	26.0	40.8	22.0	39.9	18.5	148.0	50.6%
Indian Reservation	1.2	17.8	11.3	9.3	12.0	1.0	52.6	18.0%
Private	0.6	25.9	12.0	3.5	6.9	0.6	49.5	16.9%
State Trust Lands	0.4	3.9	6.3	3.3	8.9	3.8	26.6	9.1%
U.S. Forest Service	0.2	6.2	0.0	0.0	0.0	0.0	6.4	2.2%
State Wildlife Reserve - Management area	*	2.3	1.3	0.0	0.0	0.0	3.7	1.3%
U.S. Fish & Wildlife - National Wildlife Refuge	*	0.2	0.2	0.5	0.0	0.0	0.9	0.3%
State Soveriegn Lands	*	*	0.3	0.2	0.0	0.0	0.5	0.2%
State Parks and Recreation	0.0	0.5	0.0	0.0	0.0	0.0	0.5	0.2%
Colorado Portion	0.0	0.0	0.1	2.1	1.4	0.0	3.6	1.2%
Total resource	**3.4**	**82.8**	**72.3**	**40.8**	**69.0**	**23.9**	**292.3**	

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

*Amounts less than 50 million barrels

the Mahogany zone and contain a resource that averages between 40 and 100 feet thick at 25 GPT.

Resource Conflict with Conventional Oil and Gas Fields

A significant portion of the Uinta Basin's oil-shale resource, approximately 25% for each grade, is covered by conventional oil and gas fields (table 4a and 4b). Plate 6 shows all current oil and gas fields superimposed on the 25 GPT oil-shale isopach. In particular, the extensive Natural Buttes gas field covers a significant portion of land underlain by oil shale averaging 25 GPT, ranging to 130 feet thick, and under roughly 1500 to 4000 feet of cover. Furthermore, this field is expected to expand in size and cover more oil-shale-rich lands to the east. Of the 18.4 billion barrels contained in 25 GPT rock having thicknesses between 100 and 130 feet, 7.8 billion barrels, or 42%, are located under existing natural gas fields (table 4a).

However, lands where the oil-shale deposits are under less than 1000 feet of cover currently do not contain significant oil and gas activity (except the Oil Springs gas field) as compared to lands with deeper oil-shale resources (plate 6). The majority of planned oil-shale operations will be located on lands having less than 1000 feet of cover. This does not mean that oil-shale deposits located within oil and gas fields will be permanently off limits. In fact, most of the conventional oil and gas reservoirs are located far below the Mahogany zone. It simply demonstrates that regulators will need to recognize that resource conflicts exist and plan their lease stipulations accordingly.

Resource on BLM Lands Proposed for Commercial Leasing

The BLM recently published the Final Programmatic Environmental Impact Statement (PEIS), which finalizes the plan that will guide the use of lands containing oil-shale resources (U.S. Bureau of Land Management, 2008). This is the first step towards a commercial oil-shale leasing program. Within the PEIS, the BLM identified 630,971 acres of public land in Utah's Uintah and eastern Duchesne Counties as having commercial oil-shale development potential (plate 7). These lands are bounded on the north by the 3000-foot overburden contour and bounded on the south by the outcrop of the Mahogany zone. Lands excluded from future leasing include but are not limited to Wilderness Areas, Wilderness Study Areas, river corridors, and lands potentially eligible for Wild and Scenic River status.

We determined that the oil-shale resource on BLM lands proposed for commercial leasing in Utah equals approximately 69 billion barrels at the 25 GPT richness level (table 5). Nearly the entire resource at 25 GPT is between 20 and 130 feet thick. This resource includes roughly 11 billion barrels contained in deposits on the Hill Creek Extension of the Uintah and Ouray Tribal Lands, of which the surface rights are owned by the Ute Indian Tribe.

Potential Economic Resource

To calculate a more realistic resource estimate for oil-shale deposits located in the Uinta Basin of Utah and Colorado, the UGS applied several constraints to the overall total in-place resource numbers. These constraints are subjective since commercial oil-shale technologies on which to base them do not exist. The constraints used were:

1) deposits having a richness of at least 25 GPT,
2) deposits that are at least 5 feet thick,
3) deposits under less than 3000 feet of cover,
4) deposits that are not in direct conflict with current conventional oil and gas operations, and
5) deposits located only on BLM, state trust, private, and tribal lands.

With the above-mentioned constraints, the Uinta Basin's potential economic oil-shale resource equals approximately 77 billion barrels (table 6). Plate 8 shows the area within the basin of these constrained resources. This is roughly 26% of the total unconstrained resource calculated at 15 GPT of 292 billion barrels and 52% of the total unconstrained resource calculated at 25 GPT of 147 billion barrels, and is a more realistic estimate of potential recoverable resource. However, this number should not be used as an estimate of recoverable reserves, which cannot be calculated until a proven commercial technology is developed.

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Table 4a. *The amount of Uinta Basin oil-shale resource within existing conventional oil and gas fields.*

50 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-15	15-20	Total	% of Total
Located within a current oil or gas field	1.3	3.2	2.2	0.8	7.5	24.6%
Located outside a current oil or gas field	6.7	10.9	4.2	1.2	23.0	75.4%
Total resource	**8.0**	**14.0**	**6.4**	**2.1**	**30.5**	

35 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-20	20-30	30-40	40-55	Total	% of Total
Located within a current oil or gas field	0.8	2.2	5.0	3.3	4.4	4.3	19.8	26.0%
Located outside a current oil or gas field	2.4	6.3	19.4	14.4	10.3	3.5	56.3	74.0%
Total resource	**3.2**	**8.5**	**24.3**	**17.7**	**14.7**	**7.7**	**76.1**	

25 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-20	20-40	40-60	60-80	80-100	100-130	Total	% of Total
Located within a current oil or gas field	0.1	4.1	10.9	5.2	3.9	8.2	7.8	40.3	27.3%
Located outside a current oil or gas field	1.4	11.0	27.9	26.2	14.8	15.2	10.6	107.1	72.7%
Total resource	**1.5**	**15.1**	**38.8**	**31.5**	**18.7**	**23.4**	**18.4**	**147.4**	

15 GPT (resource numbers in billion barrels)

Thickness (feet)	0-15	15-100	100-200	200-300	300-400	400-500	Total	% of Total
Located within a current oil or gas field	0.2	25.0	12.7	11.9	26.4	6.9	83.3	28.5%
Located outside a current oil or gas field	3.2	57.8	59.6	28.9	42.6	17.0	209.0	71.5%
Total resource	**3.4**	**82.8**	**72.3**	**40.8**	**69.0**	**23.9**	**292.3**	

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

Table 4b. *The amount of Uinta Basin oil-shale resource within existing conventional oil and gas fields and located under less than 3000 feet of cover.*

50 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-15	15-20	Total	% of Total
Located within a current oil or gas field	0.7	2.7	2.2	0.8	6.4	24.9%
Located outside a current oil or gas field	5.1	9.5	3.5	1.2	19.3	75.1%
Total resource	**5.8**	**12.2**	**5.7**	**2.1**	**25.7**	

35 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-10	10-20	20-30	30-40	40-55	Total	% of Total
Located within a current oil or gas field	0.1	0.5	3.9	2.8	3.9	4.3	15.5	25.4%
Located outside a current oil or gas field	1.7	3.6	16.0	12.4	8.5	3.4	45.6	74.6%
Total resource	**1.7**	**4.1**	**19.9**	**15.3**	**12.4**	**7.7**	**61.1**	

25 GPT (resource numbers in billion barrels)

Thickness (feet)	0-5	5-20	20-40	40-60	60-80	80-100	100-130	Total	% of Total
Located within a current oil or gas field	*	0.7	4.8	4.7	3.2	7.4	7.1	28.0	24.9%
Located outside a current oil or gas field	1.1	7.2	22.3	20.0	11.7	12.3	9.9	84.6	75.1%
Total resource	**1.2**	**7.9**	**27.1**	**24.7**	**14.9**	**19.8**	**17.0**	**112.6**	

15 GPT (resource numbers in billion barrels)

Thickness (feet)	0-15	15-100	100-200	200-300	300-400	400-500	Total	% of Total
Located within a current oil or gas field	0.1	7.2	9.9	9.3	26.2	6.9	59.7	26.1%
Located outside a current oil or gas field	2.6	42.0	41.8	22.6	42.5	17.0	168.6	73.9%
Total resource	**2.7**	**49.2**	**51.7**	**32.0**	**68.8**	**23.9**	**228.3**	

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

*Amounts less than 50 million barrels

Table 5. *The amount of Utah's 25-GPT oil-shale resource found on lands proposed by the BLM as having commercial oil-shale leasing potential.*

Thickness	Total resource	Resource within the Hill Creek Extension sub-area[1]
feet	billion barrels	billion barrels
0-5	*	0.0
5-20	0.1	*
20-40	10.5	2.2
40-60	19.4	1.9
60-80	10.5	0.7
80-100	14.9	4.5
100-130	13.5	1.1
Total	**69.0**	**10.5**

[1]Included in total

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

*Amounts less than 50 million barrels

Table 6. *The Uinta Basin's potential economic oil-shale resource.*

Constraints: at least 25 GPT, at least 5 feet thick, under less than 3000 feet of cover, not in conflict with conventional oil and gas operations, located only on BLM, state trust, private, and tribal lands.

Thickness	Total resource
feet	billion barrels
5-20	5.3
20-40	18.2
40-60	19.4
60-80	11.6
80-100	12.3
100-130	9.9
Total	**76.7**

Note: Totals may not equal sum of components because of independent rounding

GPT = gallons of shale oil per ton of rock (42 gallons/barrel)

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Appendix

APPENDIX. *Oil-shale resource data for coreholes used in this study.*

Depths and thicknesses are in feet

API	USGS #	Type of Log			Twn	Rng	Sec	Mrd	UTM E	UTM N	Elevation	Mahogany Bed	50 GPT Zone			35 GPT Zone			25 GPT Zone			15 GPT Zone		
		Den	Son	Fischer Assay							Ground level	Depth to bed	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness
4304730384		x			1S	1E	33	UN	594423	4467525	5314	8255			0.0	8255.0	8255.5	0.5	8253.0	8257.5	4.5	8236.5	8272.5	36.0
4301330190			x		1S	1W	31	UN	581763	4467149	5427	8002			0.0	7999.5	8007.5	8.0	7992.0	8017.0	25.0	7954.5	8047.5	93.0
4301330083		x			1S	2W	26	UN	578246	4468449	5571	8287			0.0	8286.0	8288.0	2.0	8281.5	8290.0	8.5	8277.5	8304.0	26.5
4301330139			x		1S	3W	34	UN	567559	4467451	6129	8640	8640.0	8641.5	1.5	8633.5	8643.0	9.5	8629.5	8651.5	22.0	8613.0	8677.0	64.0
4301330060			x		1S	4W	25	UN	561246	4468847	6425	8939			0.0	8938.0	8940.0	2.0	8929.0	8950.5	21.5	8909.0	8960.0	51.0
4304730169			x		2S	1E	6	UN	591414	4465415	5294	7452			0.0	7448.5	7457.0	8.5	7442.5	7474.0	31.5	7400.5	7506.0	105.5
4304730774		x			2S	1E	14	UN	598151	4463089	5068	7071			0.0	7065.5	7076.0	10.5	7057.5	7093.0	35.5	7013.0	7116.5	103.5
4304730198		x			2S	1E	34	UN	596564	4457605	4991	6424	6421.5	6426.0	4.5	6419.5	6433.5	14.0	6412.5	6471.5	59.0	6315.0	6506.0	191.0
4301330226			x		2S	1W	5	UN	582936	4465589	5289	7756			0.0	7752.0	7759.5	7.5	7747.0	7773.0	26.0	7721.0	7811.0	90.0
4304730220		x			2S	1W	24	UN	589966	4460428	5021	6880			0.0	6876.5	6882.0	5.5	6869.5	6897.0	27.5	6830.0	6925.5	95.5
4301330910		x			2S	1W	29	UN	583714	4459453	5053	6647			0.0	6646.0	6649.5	3.5	6638.0	6650.5	12.5	6632.0	6681.5	49.5
4301330783		x			2S	1W	30	UN	582159	4459519	5100	6647			0.0	6645.5	6649.5	4.0	6642.5	6654.5	12.0	6635.5	6691.5	56.0
4304730186		x			2S	2E	20	UN	603202	4461428	5135	6833			0.0	6827.5	6837.0	9.5	6824.0	6853.0	29.0	6802.5	6881.5	79.0
4301330061		x			2S	2W	16	UN	575488	4462196	5650	7307	7305.0	7308.0	3.0	7303.0	7310.5	7.5	7301.0	7323.5	22.5	7265.5	7358.5	93.0
4301330117			x		2S	3W	3	UN	567824	4465830	6001	8183	8183.0	8184.0	1.0	8179.0	8185.0	6.0	8173.0	8188.5	15.5	8161.0	8198.0	37.0
4301330122		x			2S	3W	22	UN	567074	4460322	5854	7154			0.0			0.0	7157.5	7158.5	1.0	7151.0	7185.5	34.5
4301311087		x			3S	1W	7	UN	581113	4454396	5282	5825	5822.5	5827.0	4.5	5820.0	5830.5	10.5	5821.5	5844.0	22.5	5789.5	5851.0	61.5
4304730254		x			3S	2E	20	UN	602555	4450725	4920	5120	5116.0	5123.0	7.0	5110.0	5129.0	19.0	5110.0	5161.5	51.5	5034.0	5185.0	151.0
4301330786		x			3S	2W	2	UN	578909	4455194	5334	6004	6002.5	6006.0	3.5	6001.5	6010.0	8.5	5997.5	6016.0	18.5	5976.5	6027.5	51.0
4301330094		x			3S	3W	13	UN	570267	4452310	5208	5381	5381.0	5381.5	0.5	5378.0	5383.0	5.0	5378.0	5389.5	11.5	5372.5	5403.5	31.0
4301330380			x		3S	6W	7	UN	533768	4453829	6264	5559			0.0	5556.0	5563.0	7.0	5551.0	5566.5	15.5	5538.5	5582.0	43.5
4301330298		x			3S	6W	24	UN	541862	4450840	5845	4760			0.0	4759.5	4762.5	3.0	4747.5	4774.5	27.0	4745.0	4834.5	89.5
4304731936		x			4S	1E	15	UN	595764	4442476	5270	4049	4047.5	4051.5	4.0	4046.0	4058.0	12.0	4042.0	4071.0	29.0	4010.5	4083.5	73.0
4304733541		x			4S	1E	25	UN	599059	4440655	5068	3711	3710.0	3717.5	7.5	3706.5	3725.5	19.0	3704.0	3743.5	39.5	3634.5	3740.0	105.5
4301330113		x			4S	1W	6	UN	581684	4446150	5246	4575	4575.0	4575.5	0.5	4572.0	4579.0	7.0	4568.5	4587.5	19.0	4545.0	4599.5	54.5
4301331010		x			4S	1W	20	UN	582934	4441592	5187	3600	3598.0	3602.0	4.0	3595.5	3608.0	12.5	3594.0	3620.5	26.5	3571.5	3636.0	64.5
4304733080		x			4S	1W	23	UN	588103	4440829	5079	3563	3562.5	3564.5	2.0	3561.5	3570.5	9.0	3557.5	3581.0	23.5	3536.5	3604.0	67.5
4301333635		x			4S	2W	22	UN	577782	4440775	5354	3491	3491.0	3491.5	0.5	3487.0	3493.0	6.0	3484.5	3500.5	16.0	3463.5	3514.5	51.0
4301331864		x			4S	2W	24	UN	580991	4441089	5264	3563	3561.0	3565.0	4.0	3556.5	3570.5	14.0	3555.5	3584.0	28.5	3531.5	3599.5	68.0
4301330769		x			4S	3W	25	UN	571332	4440191	5578	3316	3316.0	3316.5	0.5	3315.0	3318.0	3.0	3309.0	3322.5	13.5	3299.0	3327.5	28.5
4301331935		x			4S	3W	33	UN	566086	4437836	5822	2933	2932.0	2934.0	2.0	2930.0	2935.5	5.5	2927.0	2940.5	13.5	2927.0	2954.0	27.0
4301330414		x			4S	4W	11	UN	559843	4444595	5643	4125			0.0	4124.0	4125.0	1.0	4122.5	4126.0	3.5	4122.0	4134.0	12.0
4301330838		x			4S	4W	18	UN	552287	4443132	6082	3384	3382.5	3383.5	1.0	3381.5	3386.0	4.5	3381.0	3392.0	11.0	3374.0	3400.0	26.0
4301320179		x			4S	5W	9	UN	546236	4444283	6081	3594	3593.5	3595.0	1.5	3591.0	3597.0	6.0	3590.5	3603.0	12.5	3569.5	3608.0	38.5
4301330444		x			4S	6W	22	UN	538703	4441689	6771	2480	2479.5	2481.5	2.0	2477.0	2484.0	7.0	2473.5	2489.5	16.0	2462.0	2499.0	37.0
4301330016		x			4S	7W	25	UN	532324	4439412	6468	1584	1582.5	1587.0	4.5	1581.0	1590.5	9.5	1561.0	1594.0	33.0	1543.5	1616.5	73.0
4304730175			x		5S	19E	28	SL	601735	4466835	5186	6901			0.0	6896.5	6904.0	7.5	6896.5	6918.0	21.5	6885.0	6950.5	65.5
4304733710		x			5S	3E	6	UN	611612	4437308	4730	3096	3088.5	3099.0	10.5	3087.0	3120.0	33.0	3059.0	3128.5	69.5	2962.5	3146.5	184.0
4301330823		x			5S	3W	3	UN	566893	4435633	6006	3012	3012.0	3014.0	2.0	3010.5	3017.0	6.5	3005.5	3023.0	17.5	2997.5	3038.0	40.5
4301330785		x			5S	3W	5	UN	564551	4436479	6024	2932	2928.0	2936.5	8.5	2923.5	2944.0	20.5	2923.0	2961.5	38.5	2900.0	2970.5	70.5
4301331710		x			5S	3W	16	UN	565710	4433207	6212	2940	2936.0	2942.0	6.0	2935.5	2949.5	14.0	2930.5	2955.5	25.0	2918.5	2969.5	51.0
4301331575		x			5S	3W	28	UN	565777	4429638	6480	2816	2811.5	2820.5	9.0	2808.0	2826.0	18.0	2805.0	2834.0	29.0	2791.0	2848.5	57.5
4301330756		x			5S	4W	2	UN	560070	4435592	6105	2792	2790.0	2795.0	5.0	2789.5	2801.5	12.0	2781.5	2805.5	24.0	2775.5	2825.5	50.0
4301332586		x			5S	4W	14	UN	559316	4433097	6227	2692	2689.0	2694.5	5.5	2686.5	2700.5	14.0	2680.5	2705.0	24.5	2674.0	2723.5	49.5
4301331815		x			5S	4W	36	UN	561741	4428396	6372	2416	2411.0	2417.5	6.5	2408.0	2427.5	19.5	2404.5	2436.0	31.5	2395.5	2458.5	63.0
4301330541		x			5S	5W	14	UN	550436	4432804	6406	2411	2408.5	2414.5	6.0	2407.0	2423.0	16.0	2402.5	2425.5	23.0	2390.5	2446.0	55.5
4301333379		x			5S	5W	32	UN	544532	4428587	7751	2706	2705.5	*2711.5*	*6.0*	2702.0	*2712.0*	*10.0*	2702.5	2719.0	16.5	2685.5	2720.5	35.0
4301332737		x			5S	6W	14	UN	539698	4432382	6496	1614	1610.5	1616.5	6.0	1610.0	1625.0	15.0	1604.5	1629.0	24.5	1586.5	1647.0	60.5
	U181			x	5S	8W	15	UN	520121	4433058	6635	246	243.5	250.5	7.0	242.0	258.5	16.5	235.0	259.5	24.5	233.5	284.5	51.0
	U172			x	5S	8W	20	UN	516652	4430457	7217	225	223.5	225.5	2.0	221.0	228.5	7.5	221.0	238.5	17.5	221.0	254.0	33.0
4304730777		x			6S	19E	14	SL	605679	4460783	5148	6662	6661.0	6662.5	1.5	6654.5	6667.5	13.0	6652.5	6686.5	34.0	6612.0	6708.0	96.0
4304730155		x			6S	20E	14	SL	615304	4462172	4966	5727			0.0			0.0	5724.5	5727.5	3.0	5720.0	5737.5	17.5
4304731571			x		6S	21E	28	SL	621813	4458242	4961	5040			0.0			0.0	5039.0	5040.0	1.0	5034.5	5054.5	20.0
4301333581		x			6S	4W	2	UN	560001	4426942	6799	2254	2252.0	2255.0	3.0	2248.0	2263.0	15.0	2242.5	2271.5	29.0	2231.0	2293.5	62.5
4301330405		x			6S	4W	23	UN	559325	4421669	6780	1755	1753.5	1756.5	3.0	1751.5	1761.5	10.0	1747.5	1771.0	23.5			*39.5*
4301330496		x			6S	5W	21	UN	547147	4422129	7510	1798	1795.0	1806.0	11.0	1793.5	1816.5	23.0	1790.0	1823.0	33.0	1779.0	1834.5	55.5

APPENDIX *continued*

API	USGS #	Type of Log			Twn	Rng	Sec	Mrd	UTM E	UTM N	Elevation	Mahogany Bed	50 GPT Zone			35 GPT Zone			25 GPT Zone			15 GPT Zone		
		Den	Son	Fischer Assay							Ground level	Depth to bed	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness
4301330496		x			6S	5W	21	UN	547147	4422129		1798	1795.0	*1801.0*	*6.0*	1793.5	*1811.5*	*18.0*	1790.0	1823.0	33.0	1779.0	1834.5	55.5
4304731018		x			7S	20E	15	SL	614974	4452081	4959	5152			0.0	5150.5	5152.5	2.0	5147.0	5155.5	8.5	5143.5	5171.5	28.0
4304731381		x			7S	20E	35	SL	616012	4447534	4830	4404			0.0	4400.5	4409.0	8.5	4394.0	4421.0	27.0	4368.5	4439.5	71.0
4304733575		x			7S	22E	25	SL	636669	4448686	5503	4149			0.0			0.0	4144.5	4156.0	11.5	4139.5	4173.5	34.0
4304731683			x		7S	23E	24	SL	646687	4450866	5675	3607			0.0			0.0	3606.5	3611.5	5.0	3600.5	3618.5	18.0
4301330770		x			8S	16E	26	SL	577333	4437612	5532	3167	3165.5	3168.5	3.0	3164.0	3171.0	7.0	3164.0	3179.0	15.0	3146.0	3188.0	42.0
4301331372		x			8S	16E	28	SL	574589	4437016	5618	3106	3106.0	3107.5	1.5	3105.5	3111.0	5.5	3096.5	3112.0	15.5	3094.0	3136.0	42.0
4301331112		x			8S	16E	32	SL	572548	4435907	5745	3082	3080.0	3083.0	3.0	3078.5	3088.0	9.5	3074.5	3092.5	18.0	3067.5	3109.0	41.5
4301331508		x			8S	16E	36	SL	579457	4435643	5367	2931	2928.5	2934.0	5.5	2927.5	2941.5	14.0	2924.0	2951.5	27.5	2880.5	2952.0	71.5
4301330690		x			8S	17E	20	SL	583320	4439272	5266	3376	3373.0	3379.0	6.0	3369.5	3386.5	17.0	3363.5	3400.5	37.0	3346.0	3421.5	75.5
4301333013		x			8S	17E	32	SL	582180	4436019	5249	3015	3012.0	3017.5	5.5	3007.5	3018.0	10.5	3006.5	*3031.5*	*25.0*	3000.0	3050.5	50.5
4304733015		x			8S	17E	36	SL	588975	4436927	5059	3193	3190.5	3195.5	5.0	3187.0	3203.5	16.5	3183.0	3214.5	31.5	3154.0	3233.0	79.0
4304736188		x			8S	18E	19	SL	590975	4439383	4980	3354	3352.5	3355.0	2.5	3349.5	3359.5	10.0	3347.0	3374.0	27.0	3323.5	3385.5	62.0
4304731116		x			8S	18E	32	SL	592605	4436146	4930	3066	3064.0	3068.0	4.0	3062.0	3075.5	13.5	3058.0	3085.0	27.0			*66.5*
4304731345		x			8S	18E	36	SL	598192	4436204	4831	3112	3110.0	3114.5	4.5	3109.0	3120.5	11.5	3102.5	3133.5	31.0	3075.5	3152.0	76.5
4304715804			x		8S	20E	15	SL	614534	4442239	4686	3576	3572.0	3582.0	10.0	3565.0	*3600.0*	*35.0*	3532.0	3641.0	109.0	3400.5	3654.0	253.5
4304733421		x			8S	20E	36	SL	617917	4437124	4661	2963	2959.0	2966.5	7.5	2953.0	2981.0	28.0	2925.5	3007.0	81.5	2750.0	3035.5	285.5
4304733794		x			8S	21E	1	SL	627733	4445434	5167	3434			0.0	3430.5	3434.0	3.5	3425.5	3435.0	9.5	3417.0	3453.5	36.5
4304730026		x			8S	21E	12	SL	628213	4443383	5017	3695			0.0	3694.5	3695.5	1.0	3689.5	3701.5	12.0	3681.5	3740.0	58.5
4304731609		x			8S	21E	16	SL	622983	4442058	4750	3413	3412.0	3415.5	3.5	3405.5	3430.0	24.5	3399.5	3469.5	70.0	3270.5	3492.0	221.5
4304731065		x			8S	21E	19	SL	620216	4439938	4682	3314	3312.5	3318.0	5.5	3307.5	3324.5	17.0	3278.5	3357.5	79.0	3146.0	3389.0	243.0
4304731604		x			8S	21E	21	SL	622232	4440822	4703	3316	3314.0	3321.5	7.5	3307.5	3336.5	29.0	3273.5	3380.5	107.0	3196.0	3445.0	249.0
4304733903		x			8S	21E	22	SL	625124	4441280	4784	3326	3322.0	3328.0	6.0	3318.5	3347.0	28.5	3292.5	3379.0	86.5	3121.5	3404.0	282.5
4304731253		x			8S	21E	24	SL	627525	4440529	4819	3228	3225.0	3232.5	7.5	3216.5	3250.5	34.0	3186.0	3298.5	112.5	2926.5	3301.0	374.5
4304733746		x			8S	21E	32	SL	621913	4437545	4699	3054	3050.5	3058.5	8.0	3047.5	3075.5	28.0	3009.5	3094.5	85.0	2880.0	3130.0	250.0
4304733252		x			8S	21E	36	SL	628094	4438025	4759	2914	2910.0	2920.0	10.0	2906.5	*2944.5*	*38.0*	2870.0	2992.0	122.0	2800.0	3200.0	400.0
4304733287		x			8S	21E	36	SL	627253	4437256	4749	2914	2909.5	2919.0	9.5	2901.5	2935.5	34.0	2874.0	2965.0	91.0	2750.0	3019.0	269.0
4304731810		x			8S	22E	7	SL	628565	4443416	5036	3705			0.0	3703.0	*3706.0*	*3.0*	3698.5	*3708.5*	*10.0*	3663.0	3777.0	114.0
4304734710		x			8S	22E	15	SL	634039	4441795	5052	3491			0.0	3490.0	3503.5	13.5	3487.0	3532.0	45.0	3383.0	3560.0	177.0
4304731355		x			8S	22E	20	SL	630418	4440611	4793	3163	3162.5	3166.0	3.5	3152.0	3174.5	22.5	3129.0	3204.0	75.0	3056.5	3270.5	214.0
4304735123		x			8S	22E	27	SL	634781	4439405	4818	2979	2975.5	2982.5	7.0	2971.0	3002.5	31.5	2935.5	3032.5	97.0			*326.5*
4304733583		x			8S	22E	32	SL	630434	4436875	4715	2771	2767.0	2776.0	9.0	2762.0	2793.0	31.0	2728.5	2815.5	87.0	2560.5	2853.5	293.0
4304734210		x			8S	22E	35	SL	635206	4436993	4880	2837	2833.0	2843.5	10.5	2825.0	2859.0	34.0	2792.5	2891.0	98.5	2586.0	2924.5	338.5
4304734085		x			8S	23E	30	SL	639172	4439428	4899	2946	2941.5	2949.5	8.0	2932.0	2966.5	34.5	2908.0	3009.5	101.5	2661.0	3026.0	365.0
4304733453		x			8S	23E	31	SL	639640	4436958	4869	2715	2709.0	2721.0	12.0	2703.0	2740.5	37.5	2662.5	2763.0	100.5			*361.5*
4304736061		x			8S	23E	34	SL	644432	4438266	5076	2799	2794.5	2804.5	10.0	2786.5	2820.0	33.5	2754.0	2851.5	97.5	2627.5	2965.0	337.5
4304732106		x			8S	24E	2	SL	654670	4445356	5518	2935			0.0			0.0	2931.0	2937.5	6.5	2918.0	2964.0	46.0
4304732260		x			8S	25E	5	SL	659579	4446649	5637	2798			0.0	2797.5	2799.0	1.5	2794.5	2810.5	16.0	2786.0	2854.0	68.0
4304730066			x		8S	25E	34	SL	662570	4438670	5567	1467	1463.5	1470.5	7.0	1460.0	1486.5	26.5	1431.5	1522.5	91.0	1370.5	1807.5	437.0
4301330997		x			9S	15E	2	SL	567861	4435024	5992	3003	2999.5	3007.5	8.0	2995.0	3012.5	17.5	2991.0	3020.0	29.0	2959.0	3031.5	72.5
4301331479		x			9S	15E	14	SL	568546	4431488	6217	2928	2924.0	2931.5	7.5	2920.0	2938.0	18.0	2915.5	2944.0	28.5	2906.0	2963.0	57.0
4301331002		x			9S	16E	11	SL	578569	4432824	5581	2888	2888.0	2888.5	0.5	2884.5	2890.0	5.5	2881.0	2898.0	17.0	2869.0	2913.5	44.5
4301330446		x			9S	16E	29	SL	573060	4428709	6212	2808			0.0	2803.5	2810.5	7.0	2797.5	2816.5	19.0	2790.0	2834.0	44.0
4301331425		x			9S	17E	2	SL	587009	4434058	5066	2785	2781.5	2788.5	7.0	2778.5	2797.0	18.5	2768.5	2804.0	35.5	2734.0	2839.0	105.0
4301330926		x			9S	17E	7	SL	581764	4433587	5279	2803	2801.0	2805.5	4.5	2797.5	2808.0	10.5	2796.0	2817.5	21.5	2795.5	2836.0	40.5
4304731129		x			9S	17E	14	SL	587851	4431749	5157	2647	2646.5	2648.5	2.0	2644.5	*2654.5*	*10.0*	2641.5	2663.5	22.0	2632.0	2676.0	44.0
4301330552		x			9S	17E	16	SL	584969	4431996	5243	2671	2668.5	2673.0	4.5	2668.0	2681.0	13.0	2664.5	2695.5	31.0	2654.0	2718.0	64.0
4301332787		x			9S	17E	23	SL	587015	4429669	5212	2440	2437.0	2442.5	5.5	2433.5	2449.5	16.0	2430.0	2461.5	31.5	2405.5	2475.0	69.5
4301330601		x			9S	17E	30	SL	581871	4428750	5520	2493	2490.0	2496.0	6.0	2489.5	2505.0	15.5	2484.0	2517.0	33.0	2474.0	2539.5	65.5
4304735775		x			9S	18E	2	SL	597049	4435328	4857	3029	3027.0	3030.0	3.0	3023.0	3034.0	11.0	3020.5	3046.5	26.0			*64.5*
4304720011			x		9S	19E	9	SL	603012	4432650	4689	2692	2688.5	2694.5	6.0	2685.5	2711.0	25.5	2663.0	2722.5	59.5	2578.0	2731.0	153.0
4304732457		x			9S	19E	13	SL	607644	4431670	4649	2522	2518.5	2525.0	6.5	2518.0	2539.0	21.0	2490.5	2541.5	51.0			*126.5*
4304732227		x			9S	19E	24	SL	608484	4430846	4691	2509	2506.5	2512.0	5.5	2502.5	2520.0	17.5			*35.5*			*88.5*
4304732237		x			9S	19E	26	SL	606224	4428358	4795	2369	2365.0	2373.0	8.0	2361.5	2387.0	25.5	2339.0	2391.0	52.0	2273.0	2402.0	129.0
4304730749		x			9S	20E	4	SL	612958	4435952	4649	2845	2843.0	*2849.0*	*6.0*	2842.0	*2863.0*	*21.0*	2833.5	2873.5	40.0	2784.5	2898.5	114.0
4304730434		x			9S	20E	10	SL	614391	4433457	4747	2614	2610.5	2616.0	5.5	2605.5	2628.5	23.0	2579.0	2646.0	67.0	2354.0	2672.5	318.5
4304716529			x		9S	20E	27	SL	615687	4429710	4824	2420	2414.0	2425.0	11.0	2411.0	2449.0	38.0	2385.0	2474.0	89.0	2173.5	2494.5	321.0
	U043			x	9S	20E	36	SL	619748	4426886	4941	2303	2299.0	2305.5	6.5	2294.0	2312.0	18.0	2268.0	2335.5	67.5	1953.5	2356.5	403.0
4304734875		x			9S	21E	8	SL	621820	4434470	4688	2641	2638.0	2646.0	8.0	2631.0	2660.5	29.5	2600.5	2684.5	84.0			*358.5*
4304734747		x			9S	21E	10	SL	625111	4434922	4821	2819	2813.0	2825.0	12.0	2808.0	2845.5	37.5	2787.0	2877.5	90.5	2513.5	2900.0	386.5
4304732084		x			9S	21E	13	SL	627413	4433215	4811	2588	2583.0	2602.0	19.0	2575.5	2629.0	53.5	2538.0	2649.0	111.0	2307.5	2715.0	407.5
4304734640		x			9S	21E	17	SL	622172	4431988	4851	2533	2526.5	2538.5	12.0	2524.0	2567.5	43.5	2498.5	2588.5	90.0	2259.0	2601.5	342.5
4304734584		x			9S	21E	21	SL	623480	4431229	4875	2472	2465.5	2476.5	11.0	2462.5	2503.5	41.0	2435.0	2520.5	85.5	2213.5	2538.5	325.0
4304731744		x			9S	21E	25	SL	627893	4430012	4936	2330	2321.5	2336.5	15.0	2320.0	2367.5	47.5	2288.5	2387.5	99.0	2029.5	2399.0	369.5

APPENDIX *continued*

API	USGS #	Type of Log			Twn	Rng	Sec	Mrd	UTM E	UTM N	Elevation	Mahogany Bed	50 GPT Zone			35 GPT Zone			25 GPT Zone			15 GPT Zone		
		Den	Son	Fischer Assay							Ground level	Depth to bed	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness
	U102			x	9S	21E	26	SL	627029	4429992	4911	2313	2310.5	2325.5	15.0	2303.0	2349.0	46.0	2274.0	2376.5	102.5			*382.5*
4304734586		x			9S	21E	28	SL	622676	4429527	4903	2377	2372.5	2383.5	11.0	2368.5	2406.5	38.0	2341.5	2419.0	77.5	2148.5	2425.5	277.0
	U108			x	9S	21E	36	SL	627506	4427181	5100	2210	2205.0	2217.5	12.5	2201.0	2243.5	42.5	2179.0	2267.0	88.0	1905.0	2268.5	363.5
	U045			x	9S	22E	1	SL	637424	4436007	4810	2646	2642.0	2652.5	10.5	2633.0	2665.0	32.0	2604.0	2700.0	96.0			*334.0*
4304735012		x			9S	22E	3	SL	634472	4436548	4798	2755	2750.5	2761.5	11.0	2746.5	2779.0	32.5	2709.5	2810.5	101.0	2491.0	2842.5	351.5
4304733459		x			9S	22E	6	SL	629337	4435703	4700	2687	2683.0	2693.0	10.0	2675.5	2710.0	34.5	2646.0	2735.5	89.5	2430.0	2769.5	339.5
4304732194		x			9S	22E	19	SL	630083	4431741	4859	2425	2420.5	*2432.5*	*12.0*	2412.5	2450.0	37.5			*96.0*			*360.0*
4304730229		x			9S	22E	22	SL	634855	4431699	4861	2350	2344.0	2356.5	12.5	2339.5	2379.0	39.5	2316.0	2417.0	101.0	2050.5	2429.5	379.0
4304734795		x			9S	22E	32	SL	631370	4428124	4958	2078	2072.0	2086.5	14.5	2068.0	2115.5	47.5			*121.5*			*456.0*
	U106			x	9S	22E	36	SL	638245	4428239	4965	1966	1964.0	*1977.0*	*13.0*	1956.0	2003.5	47.5			*121.5*			*456.0*
4304736617		x			9S	23E	17	SL	641038	4432656	4904	2345	2340.0	*2352.0*	*12.0*	2334.5	2372.5	38.0	2302.0	2418.5	116.5	2022.0	2435.5	413.5
	U044			x	9S	23E	22	SL	644158	4431449	5067	2236	2231.0	2242.5	11.5	2224.0	2265.0	41.0	2192.5	2312.5	120.0			*426.0*
4304735288		x			9S	23E	31	SL	639845	4427554	5119	1996	1991.0	2003.5	12.5	1985.5	2026.5	41.0	1959.5	2061.5	102.0			*499.0*
4304735224		x			9S	23E	33	SL	642608	4428245	5270	2097	2092.5	2107.5	15.0	2085.5	2135.5	50.0	2053.5	2167.5	114.0			*429.0*
4304730568		x			9S	24E	17	SL	650223	4432794	5243	2240	2234.0	2245.0	11.0	2226.0	2263.0	37.0	2194.5	*2294.5*	*100.0*	1983.5	2322.0	338.5
4304730124			x		9S	24E	18	SL	648985	4433585	5115	2318	2312.5	2323.0	10.5	2304.0	2343.0	39.0	2274.0	2386.0	112.0	2236.5	2658.0	421.5
	U084			x	9S	24E	29	SL	651248	4430527	5432	2037	2034.5	2046.5	12.0	2025.0	2063.5	38.5	1992.0	2098.0	106.0			*399.0*
	U085			x	9S	24E	32	SL	649994	4427496	5604	1965	1961.0	*1974.0*	*13.0*	1955.0	1992.0	37.0	1924.0	2034.5	110.5			*416.0*
	U131			x	9S	24E	36	SL	657617	4428278	5471	901	898.0	905.5	7.5	889.5	918.5	29.0	869.0	963.5	94.5			*355.5*
	U082			x	9S	25E	2	SL	664245	4435783	5750	1092	1089.0	1095.5	6.5	1086.0	1108.5	22.5	1050.0	1130.5	80.5			*353.5*
	U081			x	9S	25E	16	SL	662171	4433946	5870	1171	1168.5	1176.5	8.0	1159.5	1182.5	23.0	1132.0	1220.0	88.0			*386.5*
	U092			x	9S	25E	16	SL	661008	4432488	5813	1027	1024.0	1031.5	7.5	1015.0	1038.0	23.0	993.5	1085.5	92.0	756.0	1160.0	404.0
	U030			x	9S	25E	23	SL	665059	4431820	5879	481	480.0	485.0	5.0	476.0	500.0	24.0	445.0	521.0	76.0			*333.5*
	U028			x	9S	25E	32	SL	659845	4428479	5507	516	510.0	519.5	9.5	504.5	536.5	32.0	472.0	560.0	88.0			*386.5*
	U109			x	9S	25E	33	SL	661750	4427687	5745	501	495.5	501.5	6.0	494.0	517.5	23.5			*74.5*			*327.0*
	U114			x	9S	25E	33	SL	662081	4428867	5871	504	500.5	508.0	7.5	492.5	526.0	33.5	464.0	558.0	94.0			*413.0*
4301320269		x			10S	14E	25	SL	559867	4419036	7369	1957	1954.5	1957.5	3.0	1951.5	1961.0	9.5	1949.0	1972.5	23.5	1936.0	2006.5	70.5
4301331888		x			10S	15E	12	SL	569887	4423846	6344	2167	2163.5	2171.0	7.5	2159.5	2180.5	21.0	2154.5	2187.5	33.0	2149.0	2213.5	64.5
	U180			x	10S	15E	16	SL	565851	4421009	7077	2335	2335.0	2337.0	2.0	2333.0	2340.5	7.5	2331.0	2346.0	15.0	2327.5	2365.0	37.5
4301332640		x			10S	15E	25	SL	569446	4417790	6706	1709			0.0	1706.0	1711.0	5.0	1704.5	1720.5	16.0	1701.5	1741.0	39.5
4301310757			x		10S	16E	11	SL	578275	4423537	6249	2423	2420.0	2431.0	11.0	2414.0	2452.0	38.0	2400.5	2463.5	63.0	2394.5	2516.0	121.5
4301310756			x		10S	16E	16	SL	575282	4421297	6463	2250	2250.5	2251.0	0.5	2243.5	2261.0	17.5	2239.5	2284.5	45.0	2210.5	2337.0	126.5
4301332084		x			10S	16E	23	SL	577562	4419607	6488	2152	2148.0	2154.5	6.5	2146.5	2156.5	10.0	2146.5	2167.5	21.0	2138.0	2186.5	48.5
4301330722		x			10S	17E	5	SL	582172	4424379	5866	2352	2345.5	2355.5	10.0	2344.5	2368.0	23.5	2341.5	2382.5	41.0	2322.0	2403.0	81.0
4301332057		x			10S	17E	17	SL	583398	4421115	5950	2033	2029.5	2034.5	5.0	2028.5	2042.5	14.0	2024.5	2056.0	31.5	2002.5	2064.0	61.5
4304735932		x			10S	18E	7	SL	591469	4424105	5318	2120	2116.0	*2125.5*	*9.5*	2113.0	2143.5	30.5	2088.5	2145.0	56.5	2067.5	2173.5	106.0
4304735798		x			10S	18E	9	SL	594652	4422868	5078	1823	1820.0	1828.0	8.0	1816.5	1834.5	18.0	1799.0	1834.0	35.0	1757.5	1864.0	106.5
4304731505			x		10S	18E	11	SL	597108	4423367	5079	1928	1925.0	1931.0	6.0	1921.5	1950.5	29.0	1897.0	1960.0	63.0			*118.0*
4304731752		x			10S	19E	2	SL	607303	4425931	4987	2234	2231.0	2237.5	6.5	2227.5	2247.5	20.0	2209.5	2254.5	45.0	2160.0	2279.0	119.0
4304733107		x			10S	19E	12	SL	608962	4423657	5095	2099	2095.5	2101.0	5.5	2093.0	2110.5	17.5	2074.5	2118.0	43.5	2035.0	2141.0	106.0
4304730260		x			10S	19E	16	SL	603469	4422194	5057	1812	1808.0	1815.0	7.0	1805.5	1823.5	18.0	1790.0	1830.5	40.5	1735.0	1853.5	118.5
4304730970		x			10S	19E	23	SL	607353	4421475	5210	1950	1947.0	1952.5	5.5	1942.5	1959.5	17.0	1928.0	1969.5	41.5			*112.0*
4304731898		x			10S	19E	27	SL	605763	4418769	5263	1668	1664.5	1673.0	8.5	1660.0	1686.5	26.5	1639.0	1691.5	52.5	1568.0	1710.0	142.0
4304731777		x			10S	19E	36	SL	607958	4418158	5362	1726	1724.0	1728.0	4.0	1719.0	1735.0	16.0	1715.5	1749.0	33.5	1668.0	1768.0	100.0
4304731704		x			10S	20E	6	SL	610916	4425369	4868	2082	2079.0	2083.5	4.5	2076.0	2090.0	14.0	2072.5	2104.0	31.5	2021.0	2124.5	103.5
4304720308		x			10S	20E	17	SL	611826	4422724	5093	2010	2009.5	2011.5	2.0	2007.5	2015.5	8.0	2004.0	2028.5	24.5	1980.5	2044.0	63.5
	U103			x	10S	20E	19	SL	610956	4421537	5195	1829	1829.0	1829.5	0.5	1829.0	1832.0	3.0	1827.0	1859.5	32.5			*107.0*
4304730294		x			10S	21E	8	SL	622075	4424037	5067	2019	2016.0	2022.5	6.5	2012.5	2032.0	19.5	1994.0	2041.5	47.5	1936.0	2066.5	130.5
4304734797		x			10S	21E	9	SL	623845	4424560	5076	2045	2040.0	2050.0	10.0	2036.5	2068.5	32.0	2013.0	2075.5	62.5	1903.5	2094.0	190.5
4304730504		x			10S	21E	18	SL	619499	4423304	5077	1980	1977.0	1982.0	5.0	1975.5	1991.0	15.5	1954.5	1998.5	44.0	1891.0	2023.5	132.5
4304731084		x			10S	21E	26	SL	626428	4420189	5356	1850	1848.0	1854.0	6.0	1842.0	1860.0	18.0	1820.0	1872.0	52.0	1757.5	1899.0	141.5
	U054			x	10S	21E	31	SL	619938	4417399	5345	1644	1642.0	1646.5	4.5	1641.5	1656.5	15.0	1621.5	1669.5	48.0			*144.5*
4304730724		x			10S	22E	3	SL	635056	4425645	5067	1864	1858.0	1877.0	19.0	1852.5	1901.5	49.0	1787.0	1899.5	112.5	1553.5	1927.0	373.5
4304720268		x			10S	22E	5	SL	631728	4426845	4908	1988	1986.0	1999.0	13.0	1976.5	2019.5	43.0	1946.0	2040.0	94.0	1694.0	2052.0	358.0
	U111			x	10S	22E	12	SL	637584	4424888	5192	1857	1852.5	1868.5	16.0	1846.5	1892.5	46.0	1818.0	1921.5	103.5			*337.0*
4304730536		x			10S	22E	13	SL	637451	4422858	5295	1785	1780.0	1796.0	16.0	1774.0	1817.0	43.0	1721.0	1814.0	93.0	1539.5	1842.5	303.0
	U104			x	10S	22E	16	SL	633509	4423667	5243	1930	1928.0	1942.5	14.5	1920.0	1960.5	40.5	1887.5	1977.5	90.0			*293.0*
	U101			x	10S	22E	18	SL	629032	4423509	5030	1817	1812.0	1823.0	11.0	1807.5	1844.5	37.0	1781.5	1863.5	82.0			*267.0*
	U107			x	10S	22E	24	SL	638110	4422030	4893	1266	1262.0	1274.0	12.0	1257.0	1290.5	33.5	1228.0	1317.0	89.0			*290.0*
4304730838		x			10S	22E	27	SL	634492	4420406	4970	1314	1310.5	1323.0	12.5	1304.5	1339.5	35.0	1286.0	1357.5	71.5	1094.0	1368.0	274.0
4304734237		x			10S	22E	30	SL	629617	4419861	5369	1766	1763.5	1771.0	7.5	1759.5	1781.0	21.5	1739.5	1794.0	54.5	1666.0	1817.0	151.0
	U105			x	10S	22E	36	SL	637589	4418115	5394	1400	1397.0	1404.5	7.5	1393.0	1417.5	24.5	1372.0	1435.0	63.0			*205.5*

APPENDIX *continued*

API	USGS #	Type of Log			Twn	Rng	Sec	Mrd	UTM E	UTM N	Elevation	Mahogany Bed	50 GPT Zone			35 GPT Zone			25 GPT Zone			15 GPT Zone		
		Den	Son	Fischer Assay							Ground level	Depth to bed	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness
4304735745		x			10S	23E	1	SL	646718	4426654	5426	1904	1899.5	1913.5	14.0	1893.0	1942.5	49.5	1859.5	1969.0	109.5			*342.5*
4304735030		x			10S	23E	3	SL	643481	4425844	5311	1865	1861.5	1880.0	18.5	1852.0	1903.0	51.0	1793.5	1904.0	110.5			*345.5*
4304734770		x			10S	23E	8	SL	640224	4425415	5278	1923	1919.5	1932.0	12.5	1913.5	1959.0	45.5	1885.0	*1986.0*	*101.0*			*300.0*
4304734728		x			10S	23E	10	SL	644313	4425372	5334	1795	1790.5	*1806.0*	*15.0*	1789.5	1834.5	45.0	1728.0	1837.5	109.5			*342.5*
4304734773		x			10S	23E	11	SL	645133	4425054	5437	1830	1824.0	1841.5	17.5	1817.5	1864.5	47.0	1789.0	1895.5	106.5	1563.5	1896.5	333.0
4304735721		x			10S	23E	18	SL	639653	4423800	5332	1843	1838.0	1855.0	17.0	1833.0	1876.0	43.0	1773.5	1874.5	101.0			*316.0*
4304730280		x			10S	24E	5	SL	651086	4425990	5246	1398	1394.5	1414.5	20.0	1386.0	1440.0	54.0	1357.0	1472.0	115.0	1215.0	1600.5	385.5
	U046			x	10S	24E	13	SL	656345	4423293	5292	795	792.5	801.0	8.5	784.5	821.0	36.5	756.0	854.0	98.0	478.0	863.5	385.5
	U052			x	10S	24E	17	SL	650310	4422663	5061	963	958.5	972.5	14.0	952.0	*992.0*	*40.0*	928.0	1033.5	105.5			*428.0*
	U128			x	10S	24E	21	SL	652202	4421741	5219	935	932.0	948.0	16.0	924.0	970.5	46.5			*127.5*			*485.5*
	U049			x	10S	24E	22	SL	653665	4422104	5242	887	882.0	891.0	9.0	876.0	908.0	32.0	850.5	945.5	95.0			*362.0*
	U047			x	10S	24E	26	SL	655575	4420958	5433	856	854.0	867.0	13.0	846.0	878.5	32.5	815.5	907.5	92.0	568.5	919.0	350.5
	U051			x	10S	24E	29	SL	650714	4420690	5334	1051	1046.0	1059.5	13.5	1043.0	1085.0	42.0	1016.0	1116.5	100.5			*407.5*
4304733165		x			10S	24E	30	SL	648401	4419562	5067	812	807.0	825.0	18.0	785.5	831.5	46.0	749.5	863.5	114.0	567.5	1030.0	462.5
	U050			x	10S	24E	34	SL	653424	4419210	5432	882	878.0	893.5	15.5	871.5	914.0	42.5	846.0	941.5	95.5			*387.5*
	U089			x	10S	24E	36	SL	657878	4419422	5580	669	666.0	673.5	7.5	660.0	687.5	27.5	635.0	*715.0*	*80.0*			*310.5*
	U035			x	10S	25E	4	SL	661411	4426225	5910	405	401.5	410.5	9.0	397.5	426.5	29.0	370.0	451.0	81.0	138.0	481.0	343.0
	U036			x	10S	25E	12	SL	666514	4425865	6490	170	166.5	173.5	7.0	159.0	183.5	24.5	132.0	204.0	72.0	*0.0*	*315.5*	*315.5*
	U037			x	10S	25E	15	SL	663560	4423613	6340	105	100.0	108.0	8.0	94.0	122.5	28.5	68.5	142.5	74.0	*0.0*	*324.0*	*324.0*
	U048			x	10S	25E	18	SL	658821	4423173	5435	518	515.0	523.5	8.5	508.0	541.5	33.5	482.0	564.5	82.5	376.0	692.5	316.5
	U139			x	10S	25E	20	SL	660479	4421647	5720	467	464.0	472.5	8.5	457.0	486.5	29.5	431.0	514.0	83.0			*318.5*
	U038			x	10S	25E	28	SL	661691	4420198	6173	393	385.0	394.5	9.5	382.5	411.5	29.0	360.0	437.5	77.5	150.0	448.0	298.0
	U029			x	10S	25E	32	SL	659647	4418774	5746	637	632.5	643.0	10.5	626.0	659.5	33.5	603.5	692.0	88.5	383.0	712.5	329.5
	U138			x	10S	25E	34	SL	663261	4418409	6560	165	162.0	169.5	7.5	158.0	180.5	22.5	136.0	198.0	62.0			*231.0*
4301332453		x			11S	16E	2	SL	577943	4415467	6258	1783			0.0	1783.0	1784.0	1.0	1790.0	1799.5	9.5	1775.5	1807.0	31.5
4301331994		x			11S	17E	8	SL	582783	4413141	6501	1739			0.0	1738.5	1740.5	2.0	1730.0	1743.5	13.5	1714.0	1767.5	53.5
4304731108		x			11S	19E	11	SL	606354	4414178	5605	1565	1564.5	1567.5	3.0	1562.5	1571.0	8.5	1557.0	1589.5	32.5	1526.5	1612.0	85.5
4304736907		x			11S	19E	17	SL	601945	4412953	5711	1544	1539.5	1547.5	8.0	1535.5	1558.5	23.0	1529.5	1574.0	44.5	1486.5	1595.0	108.5
4304731178			x		11S	20E	3	SL	613538	4415546	5134	1258	1256.5	1260.0	3.5	1252.5	1268.5	16.0	1229.0	1282.5	53.5			*130.5*
4304731068		x			11S	21E	1	SL	626342	4415714	5567	1638	1636.0	1638.5	2.5	1633.0	1643.5	10.5	1632.5	1658.0	25.5	1604.0	1681.0	77.0
4304734774		x			11S	22E	4	SL	631870	4417007	5593	1682	1679.0	1686.0	7.0	1676.0	1696.0	20.0	1655.5	1708.5	53.0	1574.5	1727.5	153.0
4304731067		x			11S	22E	8	SL	629501	4414181	5608	1514	1512.0	1516.0	4.0	1507.5	1522.0	14.5	1501.0	1537.0	36.0	1434.5	1540.5	106.0
4304734775		x			11S	22E	9	SL	631926	4415390	5686	1632	1629.0	1634.0	5.0	1626.0	1645.5	19.5	1604.5	1654.0	49.5	1540.5	1677.0	136.5
4304732840		x			11S	22E	28	SL	632428	4410149	6059	1502	1498.0	1504.5	6.5	1494.0	1513.0	19.0	1488.5	1532.0	43.5	1430.0	1549.5	119.5
4304734371		x			11S	23E	9	SL	642057	4414970	6111	1668	1664.5	1673.5	9.0	1664.5	1694.0	29.5	1638.0	1699.5	61.5	1525.0	1718.5	193.5
4304734252		x			11S	23E	10	SL	643568	4414792	5687	1111	1106.5	1116.0	9.5	1102.5	1129.5	27.0	1080.5	1142.5	62.0	913.0	1159.0	246.0
4304732558		x			11S	23E	30	SL	638393	4409510	5764	948	944.5	959.5	15.0	940.5	978.0	37.5	913.0	979.5	66.5			*216.0*
4304732853		x			11S	23E	35	SL	644834	4407987	5941	804	800.0	809.0	9.0	800.5	831.5	31.0	773.0	838.0	65.0	642.5	853.5	211.0
	U086			x	11S	24E	7	SL	647995	4415339	5250	581	577.0	591.5	14.5	572.5	608.5	36.0	553.0	624.5	71.5	355.0	624.0	269.0
	U025			x	11S	24E	17	SL	649592	4414357	5347	518	516.5	527.5	11.0	509.5	540.0	30.5			*60.5*			*228.0*
	U088			x	11S	24E	36	SL	655510	4408591	6130	349	343.0	349.5	6.5	340.0	363.0	23.0	322.5	377.5	55.0			*207.0*
	U032			x	11S	25E	3	SL	662907	4417093	6339	406	403.0	412.5	9.5	396.5	424.5	28.0	374.5	448.0	73.5	183.0	459.5	276.5
	U031			x	11S	25E	5	SL	658872	4416933	5533	448	442.5	460.0	17.5	433.0	470.0	37.0			*97.0*			*365.5*
	U137			x	11S	25E	13	SL	666321	4414219	6700	90	87.0	95.5	8.5	82.0	105.5	23.5	61.0	119.0	58.0	*0.0*	*222.0*	*222.0*
	U033			x	11S	25E	16	SL	659877	4413814	5905	383	380.5	389.0	8.5	377.0	409.5	32.5	357.0	429.0	72.0	156.0	431.5	275.5
	U034			x	11S	25E	22	SL	662521	4413059	6144	382	377.5	386.0	8.5	371.5	395.0	23.5	351.0	409.0	58.0	206.0	426.0	220.0
	U149			x	11S	25E	24	SL	665023	4413046	6500	418	414.0	421.5	7.5	409.5	436.5	27.0	386.0	452.0	66.0			*252.5*
	U039			x	11S	25E	29	SL	658422	4409929	6110	310	307.0	313.5	6.5	301.0	320.5	19.5	280.0	332.5	52.5	205.0	359.5	154.5
	U136			x	11S	25E	31	SL	656910	4408355	6295	418	415.0	421.5	6.5	411.0	431.5	20.5	394.0	444.5	50.5			*193.0*
	U013			x	12S	18E	2	SL	596300	4406500	5041	118	113.5	119.0	5.5	108.0	123.0	15.0	106.5	137.5	31.0	61.0	154.5	93.5
	U012			x	12S	18E	4	SL	592954	4405806	5180	126	125.0	125.5	0.5	122.5	129.5	7.0	114.5	138.5	24.0	110.5	181.5	71.0
	U015			x	12S	18E	26	SL	596955	4399709	5690	81	79.0	83.5	4.5	76.0	87.5	11.5	68.5	94.0	25.5	32.0	103.5	71.5
	U003			x	12S	19E	1	SL	607221	4406488	5410	513	510.5	518.5	8.0	507.5	*526.5*	*19.0*	504.0	550.5	46.5			*114.5*
	U093			x	12S	19E	2	SL	606164	4405761	5420	575	572.5	578.0	5.5	569.5	588.0	18.5	564.0	612.0	48.0	516.0	634.0	118.0
	U009			x	12S	19E	27	SL	604711	4400617	5887	520	518.5	521.0	2.5	516.0	524.5	8.5	510.0	534.0	24.0			*59.0*
	U005			x	12S	19E	30	SL	599712	4400542	5556	131			*3.0*	123.5	134.5	11.0			*31.0*			*76.5*
	U020			x	12S	20E	24	SL	616869	4401302	5503	181	179.5	184.0	4.5	177.0	187.5	10.5	169.5	201.0	31.5	136.0	240.0	104.0
4304733243		x			12S	21E	4	SL	622481	4406456	5982	1175	1173.5	1178.0	4.5	1168.0	1178.5	10.5	1167.0	1205.0	38.0	1135.5	1232.0	96.5
4304733185		x			12S	21E	22	SL	624603	4401228	6463	1099	1095.5	1103.0	7.5	1090.5	*1107.5*	*17.0*	1089.0	1135.5	46.5	1050.5	1160.5	110.0
	U069			x	12S	21E	30	SL	619930	4400826	5496	130	129.5	133.0	3.5	125.0	134.5	9.5	123.0	150.5	27.5	86.5	172.5	86.0

APPENDIX *continued*

API	USGS #	Type of Log			Twn	Rng	Sec	Mrd	UTM E	UTM N	Elevation	Mahogany Bed	50 GPT Zone			35 GPT Zone			25 GPT Zone			15 GPT Zone		
		Den	Son	Fischer Assay							Ground level	Depth to bed	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness	Top	Bottom	Thick-ness
	U070			x	12S	21E	35	SL	625945	4398702	5829	129	129.0	133.0	4.0	122.5	134.5	12.0	119.5	148.5	29.0	86.5	174.0	87.5
4304733132		x			12S	22E	5	SL	630076	4406962	6234	1438	1435.0	1442.0	7.0	1430.5	1451.0	20.5	1428.5	1474.0	45.5	1379.5	1493.5	114.0
4304733131		x			12S	22E	14	SL	634937	4403755	5826	714	709.5	717.5	8.0	705.5	728.5	23.0	704.0	750.0	46.0	649.0	769.0	120.0
4304733262		x			12S	22E	30	SL	628635	4400487	6251	808	805.0	811.0	6.0	803.0	819.5	16.5	798.5	838.0	39.5	762.0	868.5	106.5
4304734730		x			12S	23E	11	SL	645351	4405221	6004	700	695.5	706.5	11.0	691.0	723.0	32.0	668.0	731.5	63.5	579.5	746.0	166.5
4304733489		x			12S	23E	16	SL	641989	4403238	5964	651	645.5	654.5	9.0	641.5	666.5	25.0	623.0	672.0	49.0	579.0	703.0	124.0
	U087			x	12S	23E	36	SL	646100	4398839	6362	465	461.0	469.5	8.5	458.0	484.5	26.5	432.5	495.5	63.0	303.0	500.0	197.0
	U144			x	12S	24E	1	SL	656357	4406641	6340	306	301.5	308.5	7.0	298.0	320.5	22.5	278.5	332.0	53.5			*150.0*
	U055			x	12S	24E	3	SL	653158	4407920	6137	465	462.0	468.0	6.0	462.0	479.5	17.5	442.0	491.5	49.5	320.5	498.0	177.5
4304735083		x			12S	24E	7	SL	647764	4404973	6050	586	581.0	589.5	8.5	576.0	600.5	24.5	556.0	611.5	55.5	476.5	632.0	155.5
	U156			x	12S	24E	12	SL	655201	4405283	6110	75	71.5	78.5	7.0	68.0	87.0	19.0	51.0	98.5	47.5	26.0	147.5	121.5
	U091			x	12S	24E	14	SL	654533	4403991	6165	50	45.0	54.5	9.5	45.5	71.5	26.0	39.5	88.0	48.5	*0.0*	*153.5*	*153.5*
	U145			x	12S	24E	15	SL	652302	4404186	6300	385	383.5	389.5	6.0	377.5	392.0	14.5	362.5	400.0	37.5			*118.5*
	U080			x	12S	24E	19	SL	648046	4402078	6261	504	499.0	510.5	11.5	495.0	529.5	34.5	470.0	542.5	72.5	318.0	547.5	229.5
	U134			x	12S	24E	22	SL	652365	4402141	6225	140	138.0	149.0	11.0	133.5	162.5	29.0	108.0	174.0	66.0			*209.0*
	U153			x	12S	24E	25	SL	656186	4401431	6660	100	97.5	103.5	6.0	93.0	110.5	17.5	76.0	122.5	46.5	25.0	170.5	145.5
	U141			x	12S	24E	34	SL	653267	4399513	6450	100	96.0	104.5	8.5	92.0	117.5	25.5	69.5	131.5	62.0			*196.5*
	U090			x	12S	24E	36	SL	656719	4399338	6900	73	69.5	78.5	9.0	65.0	89.5	24.5	44.0	102.0	58.0	*0.0*	*183.5*	*183.5*
	U135			x	12S	25E	7	SL	658311	4406094	6540	303	300.0	306.0	6.0	296.5	315.0	18.5			*51.0*			*161.5*
	U143			x	12S	25E	17	SL	658938	4403501	6700	192	192.0	196.5	4.5	187.5	204.0	16.5	169.5	215.0	45.5	141.5	284.5	143.0
	U152			x	12S	25E	17	SL	658452	4404632	6600	212	209.0	215.5	6.5	205.0	220.5	15.5	193.0	233.5	40.5	184.0	287.5	103.5
	U140			x	12S	25E	18	SL	657356	4403625	6340	91	87.0	94.5	7.5	83.0	106.5	23.5	63.0	117.5	54.5	15.0	173.5	158.5
	U017			x	13S	18E	4	SL	594250	4396676	6090	129	127.5	131.0	3.5	124.0	134.5	10.5	117.0	142.5	25.5			*66.5*
	U018			x	13S	19E	7	SL	599386	4394268	6275	115	113.0	116.5	3.5	111.0	119.0	8.0	105.5	125.0	19.5			*51.0*
	U008			x	13S	19E	14	SL	605853	4393568	6247	167	162.5	167.5	5.0	162.0	173.0	11.0	156.0	182.0	26.0			*68.0*
	U010			x	13S	19E	34	SL	604747	4388476	6763	158			0.0			0.0	157.0	162.0	5.0	148.0	172.5	24.5
	U023			x	13S	20E	1	SL	618235	4396672	5836	167	164.0	168.5	4.5	157.5	169.0	11.5	155.5	184.0	28.5	152.0	226.5	74.5
	U021			x	13S	20E	8	SL	610525	4396747	5964	167	164.5	169.0	4.5	162.0	172.5	10.5	155.5	180.5	25.0	148.0	214.0	66.4
	U159			x	13S	20E	11	SL	616915	4395010	5908	76	75.0	78.5	3.5	71.0	79.5	8.5	68.5	93.5	25.0	33.0	105.5	72.5
	U022			x	13S	20E	14	SL	615775	4394255	6038	158	156.5	161.0	4.5	151.5	161.5	10.0	150.0	172.5	22.5	142.5	203.5	61.0
	U160			x	13S	20E	26	SL	615712	4389681	6388	78	78.0	79.5	1.5	74.5	81.5	7.0	70.5	88.5	18.0	64.0	106.0	42.0
	U161			x	13S	21E	31	SL	618866	4388973	6457	70	68.0	70.5	2.5	66.0	72.5	6.5	62.0	78.5	16.5	52.0	90.5	38.5
	U079			x	13S	22E	10	SL	633812	4395597	6427	466	466.0	*469.0*	*3.0*	460.5	*471.5*	*11.0*	454.5	481.5	27.0	422.5	525.0	102.5
	U071			x	13S	22E	17	SL	629942	4394449	6183	101	100.0	104.0	4.0	94.0	105.5	11.5	91.0	119.5	28.5	60.0	154.5	94.5
	U074			x	13S	22E	31	SL	629496	4389749	6628	148	148.0	151.5	3.5	142.0	152.5	10.5	141.0	165.0	24.0	102.5	180.0	77.5
	U072			x	13S	22E	35	SL	635700	4389409	6700	120	119.0	124.0	5.0	115.0	132.0	17.0	113.0	146.5	33.5	43.0	146.0	103.0
	U073			x	13S	22E	35	SL	635749	4388635	6727	53	51.5	56.5	5.0	47.5	59.5	12.0	46.0	76.5	30.5	15.0	102.5	87.5
	U076			x	13S	23E	26	SL	644861	4390642	6419	33	32.0	34.5	2.5	26.5	38.0	11.5	8.0	50.0	42.0	*0.0*	*120.5*	*120.5*
	U027			x	13S	24E	2	SL	654287	4397281	6789	121	116.0	123.5	7.5	112.5	134.0	21.5	92.0	148.5	56.5	*0.0*	*179.5*	*179.5*
	U177			x	13S	24E	2	SL	654056	4398315	6611	49	44.0	50.5	6.5	40.0	60.0	20.0	17.0	70.5	53.5	*0.0*	*170.0*	*170.0*
	U077			x	13S	24E	6	SL	648138	4397625	6268	190	185.0	194.0	9.0	180.5	206.0	25.5	159.5	222.0	62.5	35.0	238.0	203.0
	U041			x	13S	24E	8	SL	649145	4395648	6322	68	64.0	69.5	5.5	64.0	81.0	17.0	57.5	103.0	45.5	9.0	153.5	144.5
	U042			x	13S	24E	9	SL	651527	4396110	6497	99	98.0	*104.5*	*6.5*	98.0	*113.0*	*15.0*	75.5	*120.5*	*45.0*	0.0	148.5	148.5
	U078			x	13S	24E	10	SL	652681	4395938	6677	159	154.5	163.5	9.0	150.0	175.5	25.5	126.0	187.0	61.0	0.0	204.5	204.5
	U094			x	14S	21E	18	SL	619353	4384393	6760	81	81.0	81.5	0.5	78.5	83.5	5.0	76.5	87.5	11.0	71.0	92.5	21.5
	U095			x	14S	21E	26	SL	626480	4380217	7002	63	63.0	64.0	1.0	60.0	64.5	4.5	59.0	68.0	9.0	54.0	74.5	20.5
	U075			x	14S	22E	14	SL	635617	4386675	6989	54	53.0	57.0	4.0	49.0	60.0	11.0	49.0	72.5	23.5	9.0	88.5	79.5
	U100			x	15S	21E	12	SL	626861	4376431	7187	77			0.0	77.0	77.5	0.5	76.0	77.5	1.5	70.0	82.5	12.5
	U096			x	15S	21E	17	SL	621043	4374385	7282	107	106.0	107.5	1.5	104.0	108.5	4.5	103.0	112.0	9.0	98.0	115.5	17.5
	U098			x	15S	22E	34	SL	633492	4369213	7542	54	54.0	54.5	0.5	54.0	56.0	2.0	53.0	57.0	4.0	50.0	58.0	8.0
	U099			x	16S	22E	23	SL	633476	4361817	7728	40			0.0	39.0	40.0	1.0	37.0	40.5	3.5	36.0	44.0	8.0

Note: Numbers in italics indicate estimates

Den = Bulk density log, Son = Sonic log, Twn = Township, Rng = Range, Sec = Section, Mrd = Meridan, SL = Salt Lake Base Line and Meridian, UN = Uinta Special Meridian, GPT = gallons shale oil per ton of rock